Due service of the within Brief is hereby acknowledge this.....day of April, A. D. 1931.

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*Attorneys for Appellants.*

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CHARLES ELMORE CRO
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IN THE

# SUPREME COURT

OF THE

# UNITED STATES.

OCTOBER TERM, 1930.

No. [redacted] 43

Bandini Petroleum Company, a corporation; Commodore Petroleum Company, a corporation; Wilshire Oil Company, Inc., a corporation; Wilshire Annex Oil Company, a corporation; and Ambassador Petroleum Company, a corporation,

*Appellants.*

*vs.*

The Superior Court of the State of California, in and for the County of Los Angeles, and Honorable William Hazlett, as one of the judges thereof,

*Appellees.*

## SUPPLEMENT TO BRIEF OF APPELLEES ON MOTION TO DISMISS APPEAL OR AFFIRM JUDGMENT.

U. S. WEBB,
*Attorney-General, State of California,*
JAMES S. BENNETT,
*Attorney for Director of Natural Resources, State of California,*
*Attorneys for Appellees.*

Parker, Stone & Baird Co., Law Printers, Los Angeles.

# SUPPLEMENT TO BRIEF OF APPELLEES ON MOTION TO DISMISS APPEAL OR AFFIRM JUDGMENT.

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*Appellees.*

## SUPPLEMENT TO BRIEF OF APPELLEES ON MOTION TO DISMISS APPEAL OR AFFIRM JUDGMENT.

Eight appendices, lettered "A" to "H," are submitted herewith as a supplement to the brief of appellees on motion to dismiss appeal or affirm judgment. These appendices contain pertinent sections of the state statute to which the appeal is directed, two opinions of the Supreme

Court of California construing the statute, and quotations from encyclopedic articles, and government reports to refresh the judicial knowledge of the court.

U. S. WEBB,
*Attorney General, State of California;*

JAMES S. BENNETT,
*Attorney for Director of Natural Resources, State of California,*

*Attorneys for Appellees.*

## Appendix A.

*An act to protect the natural resources of petroleum and gas from waste and destruction; relating to the creation of a division in the department of natural resources for the prevention of such waste and destruction; providing for the appointment of a state oil and gas supervisor; prescribing his duties and powers; fixing his compensation; providing for the appointment of deputies and employees; providing for their duties and compensation; providing for the inspection of petroleum and gas wells; requiring all persons operating petroleum and gas wells to make certain reports; permitting and authorizing agreements in the interests of conservation; providing for suits by the director of the department of natural resources in the name of the people of the State of California; providing procedure for arbitration of departmental rulings; creating a fund for the purposes of the act; providing for assessment of charges to be paid by operators and providing for the collection thereof; and making an appropriation for the purposes of this act.*

[Approved June 10, 1915; Ch. 718, amended 1917; Ch. 759, amended 1919; Ch. 536, amended 1921; Ch. 912, amended 1929; Ch. 535.]

*The people of the State of California do enact as follows:*

Section 1. The division of the department of natural resources now or hereafter created for the supervision of petroleum and gas shall be in charge of a chief to be known as "state oil and gas supervisor." [Stats. 1929, p. 925.]

Sec. 3. It shall be the duty of the state oil and gas supervisor so to supervise the drilling, operation and maintenance and abandonment of petroleum or gas wells in the State of California, as to prevent, as far as possible, damage to underground petroleum and gas deposits from infiltrating water and other causes and loss of petroleum and natural gas. It shall be the duty of any person, firm or corporation engaged in operating any petroleum or gas well in this state wherein high pressure gas is known to exist, and any person firm or corporation drilling for petroleum or gas in any district in this state where the pressure of petroleum or gas is unknown, to equip any such well with casing of sufficient strength, and such other safety devices as may be necessary, in accordance with methods approved by the state oil and gas supervisor, and to use every effort and endeavor to effectually prevent blow-outs, explosions and fires. [Stats. 1929, p. 925.]

Sec. 8*b*. The unreasonable waste of natural gas by the act, omission, sufferance or insistence of the lessor, lessee or operator of any land containing oil or gas, or both, whether before or after the removal of gasoline from such natural gas, is hereby declared to be opposed to the public interest and is hereby prohibited and declared to be unlawful. The blowing, release or escape of natural gas into the air shall be prima facie evidence of unreasonable waste. [Stats. 1929, p. 927.]

Sec. 8*c*. Whenever the state oil and gas supervisor shall find that it is in the interest of the protection of oil or gas from unreasonable waste, it is declared to be lawful for the lessor, lessee, operator or other persons, firms and corporations owning or controlling royalty or

other interests in the separate properties of the same producing or prospective oil or gas field, to enter, with the approval of the state oil and gas supervisor, into agreements for the purpose of bringing about the cooperative development and operation of all or a part or parts of such field, or for the purpose of bringing about the development or operation of all or a part or parts of such field as a unit, or for the purpose of fixing the time, location and manner of drilling and operating of wells for the production of oil or gas, or providing for the return of natural gas into the sub-surface of the earth for the purpose of storage or the repressuring of an oil or gas field. Any such agreement shall bind the successors and assigns of the parties thereto in the land affected thereby and shall be enforceable in an action for specific performance. [Stats. 1929, p. 927.]

Sec. 8*d*. Upon complaint being made to the director of natural resources by any person operating in any oil field that there is occurring or threatened an unreasonable waste of gas in any field or fields and a petition is filed with said director requesting that a hearing be held to consider whether such waste is occurring or threatened, and it appearing to the director of natural resources that there is probable cause for such complaint, he shall order the state oil and gas supervisor to hold such a hearing and to fix a time and place therefor; such a hearing may also be ordered by the said director on the application of the state oil and gas supervisor. Notice of the time and place of said hearing shall be given by publication in a newspaper printed and published in the county in which the unreasonable waste of gas is alleged to be taking place or

to be threatened. Said notice shall also specify the commonly accepted name or a general description of the field or locality in which the unreasonable waste of gas is alleged to be taking place or to be threatened. The place of hearing shall be in the county or in any of the counties in which the unreasonable waste of gas is alleged to be taking place or to be threatened. Such publication shall be daily for five (5) days prior to the time of the hearing. The state oil and gas supervisor shall also send notice by mail to each lessor, lessee or operator of any oil and gas well in said field so far as the same may be known to him. No failure to send such written notice shall affect the validity of the proceeding. At such hearing all persons interested shall be entitled to be heard and may present testimony either oral or written. All witnesses shall be sworn and a transcript of the proceedings shall be kept by a stenographic reporter. All the provisions of this act in reference to the subpoenaing of witnesses and the taking of depositions shall be applicable to the hearing before the state oil and gas supervisor. Upon the conclusion of said hearing the state oil and gas supervisor shall determine whether or not there is an unreasonable waste of gas in said field, in existence or threatened, and shall also determine the extent to which the waste of gas therein occurring or threatened is unreasonable. If it shall appear that gas is being produced from any oil well or wells in quantities exceeding a reasonable proportion to the amount of oil produced from the same well or wells, even though it is shown that such excess gas is being used in the generation of light, heat, power or other industrial purpose and that there is sufficient other gas available for such uses from other wells in the same or other fields in which

the gas produced is not in excess of the amount which bears a reasonable proportion to the amount of oil produced from such other wells and that there are adequate gas-pipe-line connections between such other wells and the place of utilization of such gas the state oil and gas supervisor shall hold that such excess production of gas is unreasonable waste thereof if such holding will not cause an unreasonable waste of gas in any other field. If the waste of gas be found unreasonable an order shall be made directing that such unreasonable waste of gas shall be discontinued or refrained from to the extent stated in said order. The sale or delivery of gas to another by a lessor, lessee or operator shall be no defense, excuse or reason for any lessor, lessee or operator disobeying an order of the state oil and gas supervisor directing the discontinuance or curtailment of the production of the well or wells from which said gas is being produced where such gas is being unreasonably wasted by such buyer or by the person to whom deliveries are being made. A copy of said order must be posted in a conspicuous place upon the property affected thereby, and said order shall become final five (5) days after such posting unless appealed from as provided in section 9 hereof. [Stats. 1929, p. 928.]

Sec. 9. The lessor, lessee, or any operator or any well owner or the owner of any rig, derrick, or other operating structure, or his or its local agent, must within five (5) days from the date of the service of any order from the supervisor or his chief deputy or field deputy, other than the order contemplated by section 8*d* hereof, file with the supervisor or his deputy in the district where the property is located, a written statement that the order

is not acceptable, and that appeal from said order is taken to the board of commissioners of said district under the provisions of this act, or comply with such order. Any lessor, lessee, or operator affected by an order made pursuant to section 8*d* hereof may, within five (5) days from the posting of the copy of such order file with the supervisor written appeal therefrom to the board of commissioners of said district under the provisions of this act. Any such appeal shall operate as a stay of any order issued under or pursuant to the provisions of this act. Immediately upon filing of such notice of appeal, the deputy supervisor of the district, as secretary ex officio of the board of oil and gas commissioners, shall call a meeting of said commissioners to hear and pass upon said appeal. No commissioner shall be disqualified from sitting or acting in any appeal from any order of the state oil and gas supervisor involving the unreasonable waste of gas by reason of the fact that he is an employee of a lessor, lessee or operator who is interested in the oil or gas field affected by such order appealed from. The hearing upon said appeal before said district board of oil and gas commissioners shall be de novo and at such place in the district as the commissioners may designate, and within ten days from the taking of such appeal five days' notice in writing shall be given to the appellant of the time and place of such hearing, and for good cause the commissioners may postpone such hearing on the application of appellant, or the state oil and gas supervisor, or the field deputy in said district, for not exceeding five days. The board of commissioners after hearing shall affirm, set aside or modify said order as shall be determined by a majority of the whole board. The decision of said

board shall forthwith be filed with the oil and gas supervisor and upon such filing shall be final. [Stats. 1929, p. 929,]

Sec. 14*a*. When the decision of the state oil and gas supervisor that there is an unreasonable waste of gas occurring or threatened, shall have become final, a certified copy thereof, or if modified by the order of the board of commissioners, then a certified copy of the order as modified, shall be filed with the director of the department of natural resources. The director, unless said order is complied with voluntarily, shall have proceedings instituted in the name of the people of the State of California to enjoin unreasonable waste of gas. Such proceedings shall be instituted in the superior court for the county in which the property where the wastage is occurring or is threatened or any part thereof may lie. There may be joined in the same proceedings any number of defendants, although their properties and interests may be severally owned and their actual or threatened unreasonable wastage of gas may be separate and distinct; *provided,* the actual or threatened unreasonable waste by all of the defendants are in or with reference to the same producing or prospective oil or gas field. In such suits no restraining order shall be issued ex parte but otherwise the procedure shall be conformable with the provisions of chapter three of title seven of part two of the Code of Civil Procedure of the State of California, and no temporary or permanent injunction issued in such proceedings shall be refused or dissolved or stayed pending appeal upon the giving of any bond or undertaking or otherwise. In such proceedings the findings of the oil and gas supervisor,

unless set aside or modified by the board of commissioners, or if so modified then except to the extent so modified, shall constitute prima facie evidence of the unreasonable wastage of gas therein found to be occurring or threatened. The judgment of the court shall be appealable by any party in the same manner as other judgments rendered under said chapter. [Stats. 1929, p. 930.]

Sec. 14*b*. Whenever it appears to the director of the department of natural resources that the owners, lessors, lessees or operators of any well or wells producing oil and gas or oil or gas are causing or permitting an unreasonable waste of gas, he may institute, or have proceedings instituted, in the name of the people of the State of California, to enjoin such unreasonable waste of gas regardless of whether proceedings have or have not been instituted under section 8 hereof, and regardless of whether an order has or has not been made therein. Such proceedings shall be instituted in the superior court for the county in which the well or wells from which the unreasonable waste of gas is occurring or any thereof are situated. The owners, lessors, lessees or operators causing or permitting an unreasonable waste of gas in the same oil or gas field, although their properties and interests may be separately owned and their unreasonable waste separate and distinct, may be made parties to said action. In such suits no restraining order shall be issued ex parte, but otherwise the procedure shall be governed by the provisions of chapter three, title seven, part two of the Code of Civil Procedure of the State of California and no temporary or permanent injunction issued in such proceedings shall be refused or dissolved or stayed pending

appeal upon the giving of any bond or undertaking, or otherwise. [Stats. 1929, p. 930.]

Sec. 17. The owner or operator of any well referred to in this act shall, before commencing the work of drilling an oil or gas well, file with the supervisor, or his local deputy, a written notice of intention to commence drilling. Such notice shall also contain the following information: (1) Statement of location and elevation above sea level of the floor of the proposed derrick and drill rig; (2) the number or other designation by which such well shall be known, which number or designation shall not be changed after filing the notice provided for in this section, without the written consent of the supervisor being obtained therefor; (3) the owner's or operator's estimate of the depth of the point at which water will be shut off, together with the method by which such shut-off is intended to be made and the size and weight of casing to be used; (4) the owner's or operator's estimate of the depth at which oil or gas producing sand or formation will be encountered.

After the completion of any well the provisions of this section shall also apply, as far as may be, to the deepening or redrilling of any well, or any operation involving the plugging of any well or any operations permanently altering in any manner the casing of any well; *and provided, further,* that the number or designation by which any well heretofore drilled has been known, shall not be changed without first obtaining a written consent of the supervisor. [Stats. 1917, p. 1596.]

Sec. 17*a*. It shall be the duty of the owner or operator of any well referred to in this act to notify the super-

visor, or his deputy, in writing, in such form as the supervisor, or his deputy, may direct, of the sale, assignment, transfer, conveyance or exchange, by such owner or operator, of such well, and the land, owned or leased, upon which the well is located, within five days after such sale, assignment, transfer, conveyance or exchange. Said notice shall contain the following: (1) the name and address of the person, firm, association, corporation, trust or syndicate to whom such well was sold, assigned, transferred, conveyed or exchanged; (2) the name and location of such well; (3) the date of the sale, assignment, transfer, conveyance or exchange; (4) the date when possession was relinquished by the owner or operator; (5) a description of the land upon which such well is situated.

Every person, firm, association, corporation, trust or syndicate acquiring the ownership of any well referred to in this act, whether by purchase, transfer, assignment, conveyance or exchange, or otherwise, shall within five days after acquiring such well, and the land, owned or leased, upon which the well is located, notify the supervisor, or his deputy, in writing, of such ownership. Said notice shall contain the following: (1) the name and address of the person, firm, association, corporation, trust or syndicate from whom said well was acquired; (2) the name and location of said well; (3) the date of acquisition; (4) the date when possession was acquired; (5) a description of the land upon which such well is situated. [Stats. 1929, p. 932.]

Sec. 18. It shall be the duty of the owner and operator of any well referred to in this act to keep a careful and accurate log, core record and history, of the drilling

of such well, such log to show the character and depth of the formation passed through or encountered in the drilling of such well, and particularly to show the location and depth of the water-bearing strata, together with the character of the water encountered from time to time (so far as ascertained) and to show at what point such water was shut off, if at all, and if not, to so state in such log, and show completely the amounts, kinds and size of casing used, and show the depth at which oil-bearing strata are encountered the depth and character of same and whether all water, overlying and underlying such oil-bearing strata was successfully and permanently shut off so as to prevent the percolation or penetration into such oil-bearing strata; such core record to show depth, character, and fluid content of cores obtained, so far as determined; such history to show location and amount of sidetrack casings, tools or other material, depth and quantity of cement in cement plugs, shots of dynamite or other explosives, results of production, and other tests during drilling operations; such logs shall be kept in the local office of the owner or operator, and, together with the tour reports of said owner or operator, shall be subject, during business hours, to the inspection of the supervisor, or any of his deputies, or any of the commissioners of the district, except in the case of a prospect well as hereafter defined. Upon the completion of any well, or upon the suspension of operations upon any well, for a period of six months, if it be a prospect well, or for thirty days, if it be in proven territory, a copy of said log, core record and history, in duplicate, and in such form as the supervisor may direct, shall be filed within ten days after such completion, or after the expiration of said thirty

day period, with the field supervisor, and a like copy shall be filed upon the completion of any additional work in the deepening of any such well. The owner or operator of any well referred to in this act, or his local agent, shall file with the supervisor a copy of such log, history, and core record, or any portion thereof, at any time after the commencement of the work of drilling any such well, except a prospect well, upon written request of the supervisor, or his deputy. Such request shall be signed by the supervisor, or his deputy, and served either personally upon, or by mailing a copy of said request, by registered mail, to the last known post-office address of such owner or operator or agent.

A well shall be deemed completed, for the purposes of this act, thirty days after the well has commenced to produce oil, water, or gas, unless drilling operations are resumed before the end of the thirty-day period.

The state oil and gas supervisor shall determine and designate what wells are prospect wells within the meaning of this act, and no reports shall be required from such prospect wells until six months after the completion thereof.

The owner or operator of any well drilled previous to the enactment of this act shall furnish to the supervisor or his deputy, a complete and correct log, in duplicate, and in such form as the supervisor may direct, or his deputy, of such well, so far as may be possible, together with a statement of the present condition of said well. [Stats. 1929, p. 933.]

Sec. 20. It shall be the duty of every person, association or corporation producing oil in the State of Cali-

fornia, to file with the supervisor, on or before the tenth day of each month, for the last preceding calendar month, a statement showing amount of oil and gas produced during the period indicated from each well, together with its gravity and the amount of water produced from each well, estimated in accordance with methods approved by the supervisor, and the number of days during which fluid was produced from each well, the number of wells drilling, producing or idle, owned or operated by said person, association or corporation; also what disposition was made of the gas produced from each well, including the names of persons, if any, to whom said gas was delivered, and such other information regarding gas and the disposition thereof as the state oil and gas supervisor may require; *provided,* that, upon request and satisfactory showing a longer interval may be fixed by the state oil and gas supervisor as to such reports in the case of any specific owner or operator.

This information shall be in such form as the supervisor may designate. [Stats. 1929, p. 935.]

Sec. 21. Any owner or operator of any well referred to in this act, or employee thereof, who refuses to permit the supervisor, or his deputy, or his inspector, to inspect the same, or who wilfully hinders or delays the enforcement of this act, and every person, firm, association, corporation, trust or syndicate, whether as principal, agent, servant, employee or otherwise, violating or failing, neglecting or refusing to comply with any of the provisions of this act, or failing or neglecting or refusing to furnish any report or record which may be required pursuant to the provisions of this act, or who wilfully renders

a false or fraudulent report, is guilty of a misdemeanor, and shall be punishable by a fine of not less than one hundred dollars, nor more than five hundred dollars, or by imprisonment in the county jail for not exceeding six months, or by both such fine and imprisonment, for each such offense. [Stats. 1929, p. 935.]

Sec. 21*a*. The charges hereinafter provided for are directed to be levied by the State of California as necessary in the exercise of its police power and to provide a means by which to supervise and protect deposits of petroleum and gas within the State of California, in which deposits the people of the State of California are hereby declared to have a primary and supreme interest. [Stats. 1917, p. 1598.]

Sec. 22. Charges levied, assessed and collected as hereinafter provided upon the properties of every person, firm, corporation or association operating any well or wells for the production of petroleum in this state, or operating any well or wells for the production of natural gas in this state which gas wells are situate on lands situate within two miles, as near as may be, of any petroleum or gas well the production of which is chargeable under this act, shall be used exclusively for the support and maintenance of the division of the department of natural resources charged with the supervision of petroleum and gas, and shall be assessed and levied by the department of natural resources and collected in the manner hereinafter provided. [Stats. 1929, p. 935.]

Sec. 23. Every person, firm, corporation or association operating any petroleum well or wells in this state shall annually pay a charge to the state treasurer at a uniform rate per barrel of petroleum produced for the preceding calendar year at the time and in the manner hereinafter provided, based upon a verified report as herein provided. [Stats. 1915, p. 1410.]

Sec. 24. Every person, firm, corporation or association operating any gas well or wells in this state shall annually pay a charge to the state treasurer based upon the amount of gas sold in the preceding calendar year, at a fixed rate per thousand cubic feet, at the times and in the manner hereinafter provided, based upon a verified report as herein provided. [Stats. 1917, p. 1599.]

Sec. 50. Whenever the term "supervisor" is used in this act it shall be taken to mean the "state oil and gas supervisor," the term "oil" shall include "petroleum," the term "petroleum" shall include "oil," the term "gas" shall mean natural gas coming from the earth, the term "operator" shall mean any person, firm or corporation drilling, maintaining, operating, pumping, or in control of a well in any territory which the supervisor determines to be oil or gas producing territory, the term "owner" shall include "operator" when any oil or gas well is operated or has been operated or is about to be operated by any person, firm or corporation other than the owner thereof, and the term "operator" shall include "owner" when any such well is or has been or is about to be operated by or under the direction of the owner, except that all the provisions of this act relating to assessments for the purposes of this act based upon the annual production of oil or petroleum or sale of gas, as set forth in sections 22 to 45 inclusive of this act, shall apply only to a person, firm or corporation operating an oil or petroleum or gas well, and shall not apply to the owner of such well if some person, firm or corporation, other than such owner, has been actually operating the well during the whole period for which such annual charge is made, but in the event that the actual operation of any such well changes hands during such period, the charge shall be apportioned upon the basis of the oil or petroleum or gas produced, and the lien provided for in section 41 of this act shall be a lien against the property of each and all such operators.

Words used in this act in the present tense include the future as well as the present; words used in the masculine gender include the feminine and neuter; and the neuter, the masculine and feminine; the singular number includes the plural, and the plural, the singular; "writing" includes "printing" and "typewriting." [Stats. 1929, p. 942.]

Sec. 52. If any section, subsection, sentence, clause or phrase of this act is for any reason held to be unconstitutional, such decision shall not affect the validity of the remaining portions of this act. The legislature hereby declares that it would have passed this act, and each section, subsection, sentence, clause, and phrase thereof, irrespective of the fact that any one or more other sections, subsections, sentences, clauses, or phrases be declared unconstitutional. [Stats. 1915, p. 1419.]

Sec. 53. This act shall be liberally construed to meet its purposes and the director of the department of natural resources and the supervisor shall have all powers which may be necessary to carry out the purposes of this act, and the provisions of this act shall apply to any land or wells situated within the boundaries of an incorporated city where the drilling of oil wells is now or may hereafter be prohibited until all wells thereon have been abandoned as provided in this act. [Stats. 1929, p. 943.]

This act is hereby declared to be an urgency measure necessary for the immediate preservation of the public peace and safety within the meaning of section 1 of article four of the constitution, and as such shall take effect immediately. The facts constituting such necessity are as follows:

At the present time in the oil and gas producing fields within the state there is now being blown into the air and wasted daily on the average approximately five hundred million cubic feet of gas. New fields producing heavily of natural gas are being opened up which will tend to add to the amount of natural gas being blown into the air and wasted and lost. [Stats. 1929, p. 943.]

**Appendix B.**

L. A. No. 12311. In bank. December 3, 1930.

People of the State of California on relation of Fred G. Stevenot, Director of Natural Resources of the State of California, plaintiffs and respondents, v. Associated Oil Company et al., defendants; Twin Bell Oil Syndicate, Second Twin Bell Syndicate and Star Petroleum Company, defendants and appellants.

Application for writ of supersedeas to stay effect of preliminary injunction pending appeal in an action to restrain unreasonable waste of natural gas from oil wells. Writ *denied*.

For Petitioners Twin Bell Oil Syndicate—Neil S. McCarthy, Earl L. Banta, Harmel L. Pratt, Howard P. Hall.

Amici Curiae for Petitioners—Call & Murphey, Robert B. Murphey, Asa V. Call; William L. Murphey, of counsel.

For Petitioners Robert M. Pease and Roy P. Dolley—Charles A. Son.

For Respondents—James S. Bennett; U. S. Webb, Attorney-General.

Amicus Curiae in re constitutionality of California Act relating to Conservation of Petroleum, etc.—Roland Rich Woolley.

Amicus Curiae for Appellants—Arthur R. Smiley.

Amici Curiae in support of Petitioners—Rush M. Blodgett, George W. Nilsson; Charles H. King, of counsel.

This is a petition for a writ of supersedeas to stay the effect of a preliminary injunction pending an appeal therefrom by the petitioners herein.

The action was commenced in the county of Los Angeles on September 11, 1929, and in the name of the People on the relation of Fred G. Stevenot, Director of Natural Resources of the State of California against some forty-three defendants who are oil producers owning oil wells and leases in the Santa Fe oil field in said county. The purpose of the action is to restrain the alleged unreasonable waste of natural gas from the wells of the defendants. In response to the order to show cause the defendants appeared and after an extended hearing the superior court granted a temporary injunction, the terms of which were complied with except by the defendants Twin Bell Syndicate, Second Twin Bell Syndicate and Star Petroleum Company, who have taken an appeal from the order granting the temporary injunction and who are the petitioners herein.

On the hearing it appeared from the allegations of the complaint and the affidavits and other evidence, both oral and documentary, in support thereof, that during the year 1928, 77,000,000,000 cubic feet of natural gas were wasted into the air from the subsurface oil and gas zones in the state of California through the operation of oil wells; that because of the increase in the production of oil since that time a proportional increase in the wastage of natural gas is taking place, and that in the Santa Fe Springs oil field alone there was at the time of the commencement of the action a wastage of natural gas to the extent of approximately 500,000,000 cubic feet of gas per

day. This wastage was alleged to be unreasonable and unlawful under the terms of the so-called Oil and Gas Conservation Act. (Stats. 1915, p. 1404, as amended by Stats. 1929, p. 923.) In granting the preliminary injunction the court found that no sufficient cause had been shown why a preliminary injunction should not be issued as prayed for in the complaint; that the equities of all parties might be fairly conserved by a preliminary injunction which would limit the waste of gas by restricting the production thereof to a quantity reasonably in excess of the present outlets for the beneficial use above ground; that the total gas escapage from outlets for all uses, with a reasonable tolerance to take care of fluctuating demands and the necessary waste, would be fixed at 285,000,000 cubic feet of gas per day in said field, and the estimated potential production of oil taken at 237,-576 barrels per day distributed among lessees and other operating property units as shown by a schedule set out in the order. It was then provided in the order that the defendants be enjoined until the further order of the court: "1. From blowing, releasing, or permitting any natural gas to escape into the air from any well or wells in the Santa Fe Springs oil field before the removal of the gasoline from such natural gas. 2. From operating any well producing natural gas in the Santa Fe Springs oil field except while exercising a high degree of care in the selection and adjustment of appliances and in the use thereof for the purpose of keeping each producing well in its 'optimum gas-oil ratio'—the term 'optimum gas-oil ratio' being defined as the smallest number of cubic feet of gas which can be produced with each barrel of oil from the same well at the same time. 3. From producing

more net formation gas on the average day of each seven (7) day period from any lease or other property unit than is set forth in the 'Allowed Gas Production' column following:" The name of each operator and of each well operated is then set out in detail and opposite thereto the estimated potential in barrels of oil per day and the allowed gas production in daily average as to each well is stated. The term "Gas-oil ratio," as used in the order, is declared to be "the proportion which the total number of cubic feet of formation gas bears to the total number of barrels of net oil produced from the same well at the same time, exclusive of the quantity of gas inserted in the well for the purpose of lifting the oil." The preliminary injunction contains other provisions not necessary to be noticed, except that the court retained jurisdiction to vacate or modify the same on five days' notice. The order was dated March 19, 1930, and to be effective two days later. On March 28, 1930, the court modified its order as to allowable gas production applicable to certain wells and certain defendants operating the same, including the petitioners herein, and in such a way that instead of a gas allowance of 1200 cubic feet to a potential barrel of oil established by the original order, the petitioners were allowed approximately 2000 cubic feet of gas to a potential barrel of oil. The oil cut in the field was fifty per cent of the potential, consequently the petitioners were allowed a potential ratio of 4000 cubic feet of gas to a barrel of oil. From the order granting the temporary injunction the petitioners herein have taken an appeal.

The authority for the action in which the temporary injunction was issued is found in section 14b of the Oil

and Gas Conservation Act (Stats. 1915, p. 1404, as amended, Stats. 1929, p. 923.) The purpose of the act is stated in its amended title, whcih recites in part: "An act to protect the natural resources of petroleum and gas from waste and destruction." Section 8b of the amended act reads: "The unreasonable waste of natural gas by the act, omission, sufferance or insistence of the lessor, lessee or operator of any land containing oil or gas, or both, whether before or after the removal of gasoline from such natural gas, is hereby declared to be opposed to the public interest and is hereby prohibited and declared to be unlawful. The blowing, release or escape of natural gas into the air shall be prima facie evidence of unreasonable waste." Section 14b of the act provides in part: "Whenever it appears to the director of the department of natural resources that the owners, lessors, lessees or operators of any well or wells producing oil and gas or oil or gas are causing or permitting an unreasonable waste of gas, he may institute, or have proceedings instituted, in the name of the people of the state of California, to enjoin such unreasonable waste of gas. . . . Such proceedings shall be instituted in the Superior Court for the county in which the well or wells from which the unreasonable waste of gas is occurring or any thereof are situated. The owners, lessors, lessees or operators causing or permitting an unreasonable waste of gas in the same oil or gas field, although their properties and interests may be separately owned and their unreasonable waste separate and distinct, may be made parties to said action. In such suits no restraining order shall be issued ex parte, but otherwise the procedure shall be governed by the provisions of chapter three, title seven,

part two of the Code of Civil Procedure of the state of California and no temporary or permanent injunction issued in such proceedings shall be refused or dissolved or stayed pending appeal upon the giving of any bond or undertaking, or otherwise."

It is conceded that this court has the power, by virtue of section 4 of article VI of the Constitution and in aid of its appellate jurisdiction, to stay pending appeal the operation of a prohibitory injunction, and it is not seriously contended that the provision at the end of said section 14b that "no temporary or permanent injunction issued in such proceedings shall be refused or dissolved or stayed pending appeal upon the giving of any bond or undertaking, or otherwise," would have the effect of limiting the discretion of this court in the exercise of its constitutional power. Although the legislature may prescribe certain regulations in matters of appeal and restrict the granting of a stay of execution, it may not enact legislation which will deprive the reviewing court of its power under the Constitution to grant a writ of supersedeas in a proper case. (*United States of America v. Berg*, 202 Cal. 10, 13; *Ohaver v. French*, 206 Cal. 118.) Whether the application herein presents a proper case for the issuance of the writ is one of the principal points to be considered.

Three main contentions are advanced for the issuance of the writ: First, that the Conservation Act is unconstitutional because the enforcement of its provisions amounts to a taking of property without due process of law and if the taking be for a public purpose, that such taking is the taking of private property without compen-

sation; secondly, that the provision of the act declaring unlawful the "unreasonable waste" of natural gas is so vague, uncertain and indefinite as to be devoid of any guide or standard as to what shall constitute reasonable or unreasonable waste of natural gas; and thirdly that the order is arbitrary and violative of the due process and equal rights guaranties of the state and federal Constitutions and that the showing made on this application presents a proper case for the issuance of the writ in order to preserve the appellants' rights pending appeal.

The foregoing contentions will be considered in the order stated. The first relates to the constitutionality of the act as an alleged police measure. This question is argued extensively by counsel for the parties and more at length by numerous amici curiae supporting the position of the petitioners, who contend that the pertinent portions of the act do not constitute a valid exercise of the police power of the state. It is argued that the state has no sufficient interest in oil and gas resources within the boundaries to justify its attempt to control what the owner of the land may do with his own beyond such relations as will prevent injury or are necessary to protect the life, health and safety of its citizens. But there is no longer any doubt that this general rule has been extended so as to include measures which relate to the general welfare. In the case of *C. B. & Z. Railway v. Drainage Commissioners,* 200 U. S. 561, the Supreme Court stated at page 592: "We hold that the police power of a state embraces regulations designed to promote the public convenience or the general prosperity, as well as regulations designed to promote the public health, the public morals or the public safety." (Citing cases.) (See, also, *Bacon v.*

*Walker,* 204 U. S. 311; *Camfield v. U. S.,* 167 U. S. 519; *Noble State Bank v. Haskell,* 219 U. S. 104; *Barbier v. Connally,* 113 U. S. 27; *Village of Euclid v. Ambler Realty Co.,* 272 U. S. 365; *Zahn v. Board of Public Works,* 274 U. S. 325, 71 Law Ed. 1074; *Block v. Hirsh,* 256 U. S. 135.) The same view has heretofore been expressed by this court in *Miller v. Board of Public Works,* 195 Cal. 477. The difficulty usually arises in determining whether the particular right sought to be regulated or prohibited is subject to such regulation or prohibition and whether in the particular case the legislature has gone too far with the resultant unlawful taking. It may not be disputed that the use of private property is a right as much entitled to protection as the property itself, and an undue restriction on the use thereof is as much a taking "for constitutional purposes as appropriating or destroying it." (*Penna. Coal Co. v. Mahon,* 260 U. S. 393; *Missouri Pac. Ry. v. Nebraska,* 164 U. S. 403; *Pumpelly v. Green Bay Canal Co.,* 80 U. S. 166.) If the question between the taking of private property and a proper exercise of the police power is fairly debatable, the statute will be upheld. (*Gorieb v. Fox,* 274 U. S. 603, 71 L. Ed. 1128; *Zahn v. Board of Public Works, supra; Levy Leasing Co. Inc. v. Siegel,* 258 U. S. 242.) Also where a strong and preponderant opinion prevails in the state that a particular measure is greatly and immediately necessary to the public welfare, that factor has an important influence in establishing the limitations of the police power in a particular case (*Muller v. Oregon,* 208 U. S. 412; *Noble State Bank v. Haskell, supra*); although such a view is always subject to the qualification stated by Mr. Justice Holmes in *Penna. Coal Co. v. Mahon, supra:* "The general rule at

least is that while property may be regulated to a certain extent, if regulation *goes too far,* it will be recognized as a taking."

There are many cases and great uniformity of decision to the effect that the public has a sufficient interest in the preservation of oil and gas to justify legislation to prevent waste thereof, among which are *Ohio Oil Co. v. Indiana,* 177 U. S. 190; *Walls v. Midland Carbon Co.,* 254 U. S. 300; *Lindsley v. Natural Carbonic Gas Co.,* 220 U. S. 61; *Hague v. Wheeler,* 157 Pa. St. 324, 37 A. S. R. 736; *Quinton Relief Oil & Gas Co. v. Corporation Commissioner,* 101 Okla. 164, 224 Pac. 156; *State v. Ohio Oil Co.,* 150 Ind. 21, 49 N. E. 809; *Commonwealth v. Trent,* 117 Ky. 34, 77 S. W. 390; *Louisiana Gas & Fuel Co. v. White Brothers,* 157 La. 728, 103 So. 23. (See, also, note in 24 A. L. R., beginning at page 307.)

The argument is advanced by the petitioners and by their supporting amici curiae that the public interest cannot be invoked where the common law as to the nature of the property right in the oil and gas prevails. The rule at common law is that the owner of the land owns everything above and beneath the surface and it is contended that oil and gas beneath the surface are recognized as part of the realty and belong to the owner of the land and are a part of it so long as they are on it or in it or subject to his control. In this they are supported by the case of *Gas Products Co. v. Rankin,* 63 Mont. 372, 207 Pac. 993, where the same rule was applied to gas and oil beneath the surface as to minerals in place, such as coal and ore. But Montana appears to be the one state, among the many gas and oil producing states, which has established such a rule

of property with reference to gas and oil. By uniformity of decision elsewhere the common law rule has been modified in order to adapt it to the peculiar nature of gas and oil. The rule universally adopted, except in Montana, is expressed in *Brown v. Spillman*, 155 U. S. 665, as follows: "Petroleum gas and oil are substances of a peculiar character, and decisions in ordinary cases of mining, for coal and other minerals which have a fixed situs, cannot be applied to contract concerning them without some qualifications. They belong to the owner of the land, and are a part of it, so long as they are on it or in it, or subject to his control, but when they escape and go into other land, or come under another's control, the title of the former owner is gone. If an adjoining owner drills his own land and taps a deposit of oil or gas, extending under his neighbor's field, so that it comes into his well, it becomes his property." (Citing cases.) In this state the character of oil beneath the surface as distinguished from that of the precious metals, fixed in the veins which hold them, was well described in *Acme Oil and Mining Co. v. Williams,* 140 Cal. 681, wherein it was said at page 684: "Oil, on the contrary, is of a fluctuating, uncertain, fugitive nature, lies at unknown depths, and the quantity, extent, and trend of its flow are uncertain. It requires but a small surface area, in what is known as an oil district, upon which to commence operations for its discovery. But when a well is developed the oil may be tributary to it for a long distance through the strata which holds it. This flow is not inexhaustible, no certain control over it can be exercised, and its actual possession can only be obtained, as against others in the same field, engaged in the same enterprise, by diligent and continuous pumping.

It is the property of anybody who can acquire the surface right to bore for it, and when the flow is penetrated, he who operates his well most diligently obtains the greatest benefit, and this advantage is increased in proportion as his neighbor similarly situated neglects his opportunity." The same rule would apply to natural gas. It is common knowledge that the surface right to prospect for and recover oil and gas, apart from the land in which they are situated, is the subject of barter, lease or sale. When so acquired the right is subject to assessment apart from the land. (*Graciosa Oil Co. v. Santa Barbara,* 155 Cal. 140.) The generally accepted view, therefore, is that the property right of the owner or lessee of land in and to the gas and oil beneath the surface is not an absolute one. Such substances, because of their peculiarity in the natural state, partake more of the nature of common property, title to which becomes absolute when they are captured and reduced to possession. Because of their peculiar nature the public has a definite interest in their preservation from waste and destruction. This is true because of their character as natural resources and also because the public interest has attached by virtue of positive statutory law or by court judgment independent of statute. In seven states of the Union legislation making unlawful the unreasonable waste of natural gas has been upheld: Indiana: *Indiana v. Ohio Oil & Gas Co.,* 150 Ind. 21, 47 L. R. A. 627; *Ohio Oil Co. v. Indiana,* 177 U. S. 190, 44 L. Ed. 729. Kentucky: *Commonwealth v. Trent,* 117 Ky. 34, 4 Ann. Cas. 209. Wyoming: *Walls v. Midland Carbon Co.,* 254 U. S. 300, 65 L. Ed. 276. Oklahoma: *Quinton Relief O. & G. Co. v. Corp. Com.,* 101 Okla. 164, 224 Pac. 156. Louisiana: *State v. Carson Carbon Co.,* 162 La. 781, 111

So. 162. Texas: *Oxford Oil Co. v. Atlantic Oil P. Co.*, 22 Fed. (2d) 597; certiorari denied United States Supreme Court, 72 L. Ed. 1000; *R. R. Com. of Texas v. Bass*, 10 S. W. (2d) 586; *Magnolia Petroleum Co. v. Stroud*, 3 S. W. (2d) 462. Kansas: *State v. Lebow*, 280 Pac. 773, 775; *Marrs v. City of Oxford*, 32 Fed. (2d) 134. Rehearing denied, Circuit Court of Appeals, May 17, 1929. Certiorari denied, United States Supreme Court, October 21, 1929. Independently of statute the waste of gas resulting merely in a depletion of the supply in a common reservoir has been enjoined. (*Manufacturers Gas & Oil Co. v. Ind. Natural Gas Co.*, 155 Ind. 461, 57 N. E. 912, and 156 Ind. 679, 59 N. E. 169; *Louisville Gas Co. v. Ky. Heating Co.*, 117 Ky. 71, 77 S. W. 368, and 132 Ky. 435, 111 S. W. 374; *Louisiana Gas & Fuel Co. v. White Brothers*, 157 La. 728, 103 So. 23.) The leading case on the power of the state to prevent the waste of natural gas is *Ohio Oil Company v. Indiana*, 177 U. S. 190. There a statute of Indiana was sustained which made it unlawful to permit the escape of natural gas from any well for more than two days after oil or gas had been struck, without storing the same. There is considerable discussion in that case concerning the protection necessary to be accorded the correlative rights of adjoining land owners in the same field, and the petitioners herein seek to confine the holding of the Supreme Court in that case to the protection, under the exercise of the police power, of those correlative rights. But the holding in that case cannot be so limited. The decision in that case defines the so-called correlative right not necessarily as a right to a fixed distributive or proportional share of the oil and gas underlying the surface, which no other owner of soil over-

lying the same reservoir may take and use beneficially, but as a coequal right to take whatever of the oil and gas can be captured, so long as waste, as defined by the statute, is not committed.

In the Ohio Oil Company case the Supreme Court, at page 204, quoted with approval from *Hague v. Wheeler*, 157 Penn. St. 324, as follows: "'Now it is doubtless true that the public has a sufficient interest in the preservation of oil and gas from waste to justify legislation on the subject. Something has been done in this direction already by the acts regulating the plugging of abandoned wells. . . . In the disposition he may make of it (private property) he is subject to two limitations. He must not disregard his obligations to the public. He must not disregard his neighbor's rights. If he uses his product in such a manner as to violate any rule of public policy, or any positive provisions of the written law, he brings himself within the reach of the courts. If the use he makes of his own, or its waste, is injurious to the property or the health of others, such use or waste may be restrained, or damages recovered therefor; but, subject to these limitations, his power as an owner is absolute until the legislature shall, in the interest of the public, as consumers, restrict and regulate it by statute.'" Again the Supreme Court, in the same case, at page 207, referring to *Townsend v. State*, 147 Indiana 624, said: "In a full opinion reviewing the nature of the ownership in oil and natural gas, the power of the state to regulate and control their use and waste in the interest of all those within the gas field and of the public at large was elaborately considered. Reviewing its own previous adjudications, which we have

cited, and those of the supreme court of the state of Pennsylvania, to which we have also referred, it was decided that the owners of the surface of the land within the gas field, whilst they had the exclusive right on their land to sink wells for the purpose of extracting the oil and gas, had no right of property therein until by the actual drawing of the oil and gas to the surface of the earth they had reduced these substances to physical possession. It was further held that in consequence of the nature of the deposits, of their transmissibility, of their interdependence, of the rights of all and of the public at large, the state could lawfully exercise the power to regulate the right of the surface owners among themselves to seek to obtain possession, and to prevent the waste of the products in which all the surface owners within the area wherein the gas and oil were deposited, as well as the public, had an interest, because in the preservation of these substances the well-being and prosperity of the entire community was largely involved. And it was upon the opinion announced in that case that the court rested its decree in the case now under review."

Section 21a of our statute provides, among other things, for the levy of charges necessary to supervise and protect deposits of oil and gas within the state, "in which deposits the people of the state of California are hereby declared to have a primary and supreme interest." (Stats. 1917, p. 1598.) This declaration is in accord with the prevailing opinion, both legislative and judicial, in the many jurisdictions where the exploitation and waste of such natural resources as gas and oil have attracted and received intelligent public consideration.

Whatever refinements may be suggested as to the definition of the nature of the property right in gas and oil beneath the surface and uncaptured, we are entirely satisfied that the waste of these natural resources may be regulated and the unreasonable waste thereof may be prohibited in the exercise of the police power of the state, and that the statute in question is not subject to the objections first advanced by the petitioners.

It is next contended that the term "unreasonable waste" has not been defined by the statute; that it is so uncertain in its meaning and so devoid of a rule or standard of conduct that an ordinary person cannot determine in advance what he may and may not do, and that it is therefore void within the doctrine of such cases as *International Harvester Co. v. Kentucky*, 234 U. S. 216, 221; *U. S. v. L. Cohen Grocery Co.*, 255 U. S. 81, 65 L. Ed. 516; *Conally v. General Construction Co.*, 269 U. S. 385, 391; *U. S. v. Frink Dairy Co.*, 274 U. S. 445, 71 L. Ed. 1146; *Hewitt v. Board of Medical Examiners*, 148 Cal. 590.)

Courts are entitled to take judicial notice of the condition and development of the petroleum industry. (*Gilbreath v. States Oil Corp.*, 4 Fed. Rep., 2d Series, 232.) The present status of the importance of petroleum and gas in industry is stated in the recent case of *Boone v. Kingsbury*, 206 Cal. 148, 181. Courts may also take judicial notice of all matters of science and common knowledge. (*Reynolds v. McMan Oil & Gas Co.*, 11 S. W., 2d Series, 778, 784.) Facts relating to the general nature of so-called oil "sands" which also contain natural gas, such as are found in this state, and the physical and economic laws governing oil and gas production, the present

general economic status and the necessity and pressing demand for conservation to prevent waste in the gas and oil producing industry, may be found in the following scientific reports referred to by counsel, viz.: Report 111 of the Federal Oil Conservation Board to the President of the United States, Feb. 25, 1929; Bulletin 194, Department of the Interior, Petroleum Technology 61, published as a report of the Bureau of Mines in 1921 by Carl H. Beal and J. O. Lewis; Bulletin 232, Department of the Interior, Manual for Oil and Gas Operations, prepared by T. E. Swagart and C. E. Beecher, 1923; Technical Paper 322, Department of the Interior, Experiments in the Use of Back Pressures on Oil Wells, T. E. Swigart and C. R. Bopp, 1924; Department of Commerce, Mineral Resources of the United States, 1927, Part II, pages 129-137, Natural Gas, by G. R. Hopkins and H. Backus; Department of Commerce, United States Bureau of Mines, 1929, H. C. Miller, Function of Natural Gas in the Production of Oil; Reports of American Bar Association, 1927, vol. 52, pages 577 et seq.

For present purposes it need only be noted that oil in this state is found under layers of rock in a sand or sandstone formation termed a lentille or "lentil," under pressure caused by the presence of natural gas within the formation. The layers of rock thus form a gas-tight dome or cover for the oil reserve. The oil adheres in the interstices between the sand particles. The natural gas may be in a free state at the top of the dome, but is also in solution with the oil, thus increasing the fluidity of the oil and the ease with which the oil is lifted with the gas in solution when the pressure on the gas is released by drilling into the oil "sand." It is estimated that only from ten to

twenty-five per cent of the total amount of oil deposited in a reservoir is ultimately recovered, depending on the natural characteristics of the reservoir and the methods employed in utilizing the lifting power of the gas. The importance of gas in the oil-producing industry has, therefore, become a question of great concern to the industry itself and to government, to the end that its function may be fully utilized without waste. It fairly appears on this application that, depending on its location in the oil reservoir, the extent of the oil "sand," the degree of pressure within the formation, the amount of oil in the "sand," the amount of gas in solution with the oil, the porosity of the "sand" and other considerations, each oil and gas well has a best mean gas and oil ratio in the utilization of the lifting power of the gas and the production of the greatest quantity of oil in proportion to the amount of gas so utilized, and which may be computed as to each individual well to a reasonable degree of certainty and be regulated accordingly. Gas, therefore, which has been allowed to come to the surface without its lifting power having been utilized to produce the greatest quantity of oil in proportion, may be said to amount to an unreasonable waste of natural gas.

That the legislature intended to prohibit such a waste of natural gas, and so defined the term "unreasonable waste," is quite apparent from a consideration of the provisions of a portion of section 8d of the act. Section 8d relates to the procedure upon complaint of undue waste filed with the director of natural resources, and the portion thereof immediately quoted is offered to us by petitioners as the only statement in the act of any standard of "unreasonable waste," viz.: "If it shall appear that gas is being pro-

duced from any oil well or wells in quantities exceeding a reasonable proportion to the amount of oil produced from the same well or wells, even though it is shown that such excess gas is being used in the generation of light, heat, power or other industrial purpose, and that there is sufficient other gas available for such uses from other wells in the same or other fields in which the gas produced is not in excess of the amount which bears a reasonable proportion to the amount of oil produced from such other wells, and that there are adequate gas-pipe-line connections between such other wells and the place of utilization of such gas, the state oil and gas supervisor shall hold that such excess production of gas is unreasonable waste thereof if such holding will not cause an unreasonable waste of gas in any other field." It would seem, therefore, that the legislature has plainly adopted the standard so expressed, viz.: that gas may not be produced, under existing conditions where the production thereof so greatly exceeds the market demand therefor, in quantities exceeding a reasonable proportion to the amount of oil produced, as the standard to be applied and beyond which the production is prohibited as being an unreasonable waste of natural gas.

The standard so adopted by the legislature is, we think, not objectionable as being too vague or uncertain of application. The best mean ratio, or the amount of gas which bears a reasonable proportion to the amount of oil produced, may vary for each reservoir or deposit of oil, depending on the natural characteristics above mentioned, and may, and probably does, vary for each well drilled into the same reservoir, depending on the location of the well and other factors. Therefore, because of the many

and varying conditions peculiar to each reservoir and to each well, which will bear upon a determination of what is a reasonable proportion of gas to the amount of oil produced, it may be said that it would be impossible for the legislature to frame a measure based on ratios or percentages or definite proportions which would operate without discrimination, and that what is a reasonable proportion of gas to the amount of oil produced from each well or reservoir is a matter which may be ascertained to a fair degree of certainty in each individual case. The adoption, therefore, of such a measure seems to us to be within the scope of cases upholding other legislative enactments which have employed the so-called "rule of reason." Citation of authority is not necessary to support the statement that the standard of reason has been applied in many cases where certainty is less capable of measurement than in the present case, for instance, in statutes prohibiting unreasonable restraints of trade, the common law rule of a reasonable use of water by riparian owners, the rule of law regulating the duty of care, etc. Instances "where a man's fate depends on his estimating rightly, that is, as the jury subsequently estimates it, some matter of degree," are common. (See *Nash v. United States*, 229 U. S. 373, 377.)

The so-called "price" and similar cases relied upon by the petitioners as establishing the contrary doctrine, and above cited, involve the uncertainty of man's judgment as to what is an unjust, or unreasonable price, or a current rate, or fair market value, in fluctuating or uncertain markets, so as to make the risk of conduct so great as to be without the pale of certainty required for the terms of a

statute. The case of *Hewitt v. Board of Medical Examiners, supra,* is also clearly distinguishable, in that the prohibition against gross and improbable statements in medical advertising involved therein does not define any measure upon which two persons may agree within any degree of certainty. The argument is made that the same conclusion must be reached in respect to the standard of reasonableness required by the present statute, for the reason that the standards applying the "rule of reason" in cases said to be analogous have been gleaned from or formulated by previous legislation or by many prior decisions or are within the common experience of mankind. But this argument is not persuasive when it may be said that scientific knowledge and oil and gas operating experience have achieved a similar degree of certainty in the field in which the present standard will apply. Whether the evidence sustains the ratio applied by the court in this case under such standard is a question on the merits of the appeal and is not pertinent to a determination of the merits of this application.

Objection is made to the provision of section 8b of the act that ' the blowing, release or escape of natural gas into the air shall be prima facie evidence of unreasonable waste," as inconsistent with other provisions of the act which it is claimed authorize some waste of gas in the production of oil. The state has the power generally "to prescribe the evidence which shall be received and the effect which shall be given to it in her courts, and may exert this power by providing that proof of a particular fact, or of several taken collectively, shall be prima facie evidence of another fact." (*Lindsley v. Natural Carbonic*

*Gas Co.*, 220 U. S. 61.) In prescribing that any waste shall be prima facie evidence of unreasonable waste, the state has cast upon the party found to be wasting gas the burden of justifying the same. A statute which casts the burden of proof upon the defendant in a criminal action upon the proof of certain facts for whose existence he is responsible, has been upheld. (*People v. Osaki*, 79 Cal. Dec. 244.) As applied to a civil action a statute imposing the burden of proof is freed from the objections incident to the rules inherent in a criminal prosecution and cannot be avoided for any reason suggested by the petitioner or otherwise apparent.

It is contended that the real purpose of the statute is to curtail the production of oil so as to regulate and stabilize the market price thereof. We cannot agree with this contention. Obviously the enactment is an effort on the part of the legislature to conserve for present and future needs great natural resources in which the people of the state are interested. It may be that the enforcement of the statute throughout the gas and oil producing sections of the state may have an effect upon the market price of oil. For this reason the subject matter of the act is a delicate one for legislative treatment and judicial cognizance. But the fact that the field of economic law to some extent may thus be invaded may not justify the avoidance of the statute. As we view the terms of the act the primary function of gas in the production of oil is recognized, and its complete utilization in that respect, without unnecessary waste, is attempted to be safeguarded. The additional function of the gas in providing light and heat for manufacturing and domestic purposes is also recognized, and

the effort is made to compel the fullest utilization as to both functions. The act, without doubt, was a response to a growing recognition that the continuing and increasing waste of the propulsive energy of gas underground and of its full energy above ground was unreasonable and should be inquired into and regulated, to the end that the public convenience and general prosperity of the commonwealth be promoted. Such legislation should not be stricken down because there may be an incidental and unavoidable interference in the economic field. The result complained of—the lessening of the daily production of oil—if it follow from the operation of the statute, is a matter of concern for the legislature and cannot of itself make void a police measure which is otherwise a constitutional exercise of the legislative power. "At least," as was stated in *Noble State Bank v. Haskell*, 219 U. S., at page 111, "if we have a case within the reasonable exercise of the police power, as above explained, no more need be said."

Some argument also is advanced that the statute is unconstitutional because it embraces more than one subject and that the title does not express the subjects embraced in the act; that the statute impairs the obligations of contracts and that it deprives petitioners of the equal protection of the laws and grants special privileges and immunities. We have considered these arguments and, except such as are related to the matters herein elsewhere discussed, we deem it unnecessary to give them any further notice.

The final question to be considered is whether the particular preliminary injunction ordered by the trial court

violates any constitutional guaranties. The terms of the order in establishing the gas-oil ratio have been hereinbefore specifically noted. It is contended that the enforcement of the terms of the order will require the shutting down of well No. 4 of the petitioner, Star Petroleum Company. Conceding this to be so, it is the contention of the respondents that the operator is in no position equitably to insist that that well, which is called a "waster," may operate to the manifest detriment of the other operators in the field and to the public in general. There are twelve oil and gas zones in the Santa Fe Springs oil field, varying in depth from 3450 to 8000 feet. The area of land within the oil field is divided into not less than 1145 parcels at the surface. These parcels are owned of record by more than 110 individuals and corporations. Many of the parcels are rectangles less than 75 feet by 100 feet. The Star Well No. 4 is on one of the smaller parcels, being located within a radius of 137 feet from the exterior boundaries of the parcel on which it is located. This well has withdrawn the equivalent of all the recoverable oil within said exterior boundaries and has withdrawn gas and large quantities of oil from the lands of its neighbors. Under the rule in this state such withdrawal is recognized as lawful and without trespass. Without more, however, the foregoing facts with reference to this well may be said to be insufficient upon which to base an injunctive order. But when it further appears that in the operation of this well the natural gas-oil ratio is injurious to the rights of all of the adjoining land owners and to the public in general by reason of the unreasonable waste of gas in the operation thereof, we have no hesitancy in saying that it should be shut down until more efficient methods are em-

ployed to conserve the wasted product. The statute held valid in the case of *Ohio Oil Company v. Indiana, supra,* permitted no waste of gas whatsoever for a longer period than two days after gas or oil had been struck. The margin between no waste at all and a reasonable waste in recognition of the propulsive function of the gas is largely one of fact. In the ascertainment of the fact the legislature has vested in the superior court full power and duty in the premises. It is contended by the petitioner that the statute, as applied by the court, has made it practically impossible to profitably extract the oil. This same contention was advanced with seemingly more justification, but was rejected, in the case of *Ohio Oil Company v. Indiana, supra.*

As we understand the order the natural gas outlets in the entire field were taken as 285,000,000 cubic feet of gas per day, determined by the beneficial uses to which such gas could be put, and which contained a certain tolerance for necessary and unavoidable waste and the fluctuations in the demands for the same. The court then, for safety, increased the amount by some 10,000,000 cubic feet and fixed the daily "Allowed Gas Production" for the entire field at such increased amount. It then prorated this "Allowed Gas Production" among the separate operating properties of the defendants and in connection therewith estimated the "Potential Oil Production" of the field at 237,576 barrels of oil per day. In other words, the court limited the total quantity of gas which might be produced from the field and allotted proportional amounts thereof to the separate parcels of land of the defendants based on the estimated potential oil production of each

parcel. As to the facts, there is no serious dispute. The experts whose testimony was received by the trial court were not in accord as to the proper methods to apply in enforcing cooperation in response to the statute. Reading the act as a whole, it cannot be said that the method of its enforcement adopted by the court was unlawful or improper. We find no reason at this time to interfere with the action taken. The court reserved to itself the right to modify the preliminary injunction as occasion may require, and this, we assume, the court will do if and when, by test and experience, other proper methods may be discovered and applied to the correction of the evil of unreasonable waste of this natural resource. Other points need not be discussed.

The writ of supersedeas is denied and the order to show cause is discharged.

SHENK, *J.*

We concur:

RICHARDS, *J.*
CURTIS, *J.*
PRESTON, *J.*
LANGDON, *J.*
SEAWELL, *J.*
WASTE, *C. J.*

**Appendix C.**

L. A. No. 12311. March 26, 1931.

In bank.

People of the State of California on Relation of Fred G. Stevenot, Director of Natural Resources of the State of California, plaintiff and respondent, vs. Associated Oil Company, *et al.*, defendants; Twin Bell Oil Syndicate, Second Twin Bell Syndicate and Star Petroleum Company, defendants and appellants.

This is an appeal from an order granting a preliminary injunction. The action was brought against some forty-three oil producers in the Santa Fe Springs Oil Field in Los Angeles County to enjoin the unreasonable waste of natural gas pursuant to the provisions of the so-called "Oil and Gas Conservation Act" of 1915 (Stats. 1915, p. 1404), as amended in 1929 (Stats. 1929, p. 923).

After notice and hearing the court, on March 19, 1930, issued a temporary injunction as prayed for in the complaint. The terms of this injunction were modified on March 28, 1930. From the injunction as modified this appeal was taken by three of the defendants in the action, to wit: Twin Bell Syndicate, Second Twin Bell Syndicate and Star Petroleum Company. An application was then made by these appellants for a writ of supersedeas to stay the operation of the injunction pending the appeal therefrom. This application was denied by this court on December 3, 1930. (People v. Associated Oil Co. *et al.*, 80 Cal. Dec. 607.)

The order appealed from is attacked first on the ground that the statute under which the action was brought is

unconstitutional, and secondly that the injunction issued is void as to these appellants by reason of alleged discrimination against them, but particularly as against the operation of well No. 4 of the Star Petroleum Company.

The questions involving the aileged unconstitutionality of the statute were presented for determination and were decided by this court contrary to the appellants' contentions upon the application for the writ of supersedeas. The terms of the temporary injunction were also set forth in the opinion rendered on that application.

It will be unnecessary to discuss the several questions raised by the appellants as to the alleged unconstitutionality of the statute for the reason that they are the same as those presented and determined in the former proceeding. It was also there stated by this court that, conceding the effect of the preliminary injunction to be that Star Well No. 4 would have to be shut down, the showing of the unreasonable waste of gas therefrom would justify it.

When the matter of the present appeal came on for argument on December 5, 1930, counsel for the appellants stated that the effect of the preliminary injunction had been in fact to kill Star Well No. 4, and that the circumstances thereof demonstrated the discriminatory character of the injunctive order as to that company; whereupon counsel for the respondent immediately disputed the fact. Thereafter on December 9, 1930, the respondent filed an application herein for leave to produce evidence pursuant to section 956a of the Code of Civil Procedure as interpreted in Tupman v. Haberkern, 208 Cal. 256. In response to the application an appropriate order was entered in the minutes of this court. The Hon. Leon R. Yank-

wich, a judge of the superior court in and for the county of Los Angeles, was appointed a referee to take the evidence, either orally or by affidavit, and report the same to this court. In due time the referee filed his report which consists of affidavits and exhibits attached thereto presented by the respective parties. This evidence shows beyond dispute that Star Well No. 4 has been on continuous production from a time prior to the commencement of the action until the expiration of the time covered by the referee's report, which included the entire month of December, 1930. During the month of March, 1930, when the original injunctive order was issued, the daily average production of gas in the entire Santa Fe Springs Oil Field was 565,705,000 cubic feet per day. The injunctive order fixed the allowable daily production at 334,000,000 cubic feet per day. Taking into consideration and eliminating the amount of gas put to beneficial use, the court determined that any additional blow into the air in excess of 100,000,000 cubic feet per day was unreasonable waste. The Star Petroleum Company was originally allowed 3,000,000 cubic feet per day. By the modified order this company was allowed 3,285,000 cubic feet per day. This was an allowance to these appellants of 4,000 cubic feet of gas to each barrel of oil produced as against an average of 2,600 cubic feet of gas to each barrel of oil throughout the entire field. On this state of the facts any claim of unlawful discrimination between the Star Petroleum Company and other operators in the field would seem to be without merit.

The record now before us shows that from March and June of 1930 the Star Petroleum Company far exceeded

the allowance of gas specified in the order of court, and that it came within the allowance only because the average daily production of gas in the entire field declined to such an extent that this company could not produce even the allowable amount, due to the depletion of gas in zones in the field. In January of this year the daily average of production of gas in the entire field was reduced to 177,251,000 cubic feet. This reduction was due wholly to the decrease in gas pressure in the various sands of the field. The production of oil in the whole field was necessarily reduced proportionately. It therefore appears that the very thing that the state was endeavoring to prevent, namely, the improvident and wasteful use of natural gas, has been frustrated by unregulated operations in the field or by operations conducted in spite of attempted regulation, with the result that the further recovery of oil in the discovered zones in this field has been unduly reduced by the heretofore wasteful process, and that such further recovery must depend on artificial gas repressuring or putting the wells on pumps. It is estimated that only about twenty per cent of the gas has been beneficially used and that a very large proportion of the oil deposit has not been recovered from the discovered and developed zones in this field. It would seem to require no argument to support the statement that such a situation falls within the purview of public regulation under the police power, not only to the end of protecting the correlative rights of the owners and operators in this field, but also the rights of the public which has a direct interest in safeguarding this important natural resource.

The appellants, particularly the Star Petroleum Company with reference to its Well No. 4, insist that if it had

been compelled to observe the injunctive order it would have been required to shut down the well, but there is no showing that it endeavored to comply with the order by "beaning back" (restricting the outlet), or by the employment of other means to prevent the prohibited waste. It is insisted that this appellant is being penalized because it happened to strike the top of the structure where the gas pressure was greatest. In effect this is a contention that it should be permitted to exercise a right to the prejudice of a co-equal right possessed by its neighbors in the field. This contention cannot be sustained on well known principles of law with reference to the exercise of rights in private property generally, but it also runs counter to adjudications on the subject of gas and oil development regulations by the highest court in the land. (Ohio Oil Co. v. Indiana, 177 U. S. 190; Lindsley v. Natural Carbonic Gas Co., 220 U. S. 61; Standard Oil Co. v. U. S., 221 U. S. 1; Walls v. Midland Carbon Co., 254 U. S. 300.) The decisions of the Supreme Court of the United States have recognized and determined that the states have the right to enact laws, under the police power, providing for the conservation of the oil and gas resources within their borders and that such laws, if not purely arbitrary or unreasonable, do not contravene the due process and equal protection provisions of the Federal Constitution or take property for public use without compensation. In harmony with the reasoning of the Supreme Court of the United States in the foregoing cases, conservation measures have been approved by the highest courts of the oil and gas producing states, as is shown from the many cases cited from those jurisdictions in the briefs of

respondents and amicus curiae, with the exception of Montana (Gas Products Co. v. Rankin, 63 Montana 372).

We reiterate that the legislation in question has lawfully vested in the superior court the power to determine what wastage of gas in the production of oil is reasonable or unreasonable. Whether such wastage be reasonable or unreasonable is a question of fact and should be determined in view of the necessity of one landowner to make productive use of his parcel, in view of the equal right of the adjoining owners not to be deprived of correlative production from their parcels, and in view of the right of the public to prevent the waste of that which cannot be replaced.

The preliminary injunction generally is supported by the facts presented to the court. That these particular appellants have not been discriminated against is evidenced by the terms of the order itself and by the record present before the trial court and before this court on the supplemental hearing. The order is therefore affirmed.

SHENK, *J.*

We concur:

PRESTON, *J.*
RICHARDS, *J.*
SEAWELL, *J.*
CURTIS, *J.*
LANGDON, *J.*
WASTE, *C. J.*

## Appendix D.

REPORT IV OF THE FEDERAL OIL CONSERVATION BOARD.

Washington, June, 1930.

*To the President of the United States:*

* * * * * * * *

### ECONOMICS OF NATURAL-GAS DISTRIBUTION.

Recent development in long-distance transportation of natural gas constitutes one of the most noteworthy achievements in modern economic history. Major industrial areas, hitherto dependent upon solid or liquid fuels, have been brought within the range of natural-gas service through the construction of pipe lines covering distances which, until recently, were considered beyond the limits of immediate possibility.

Recognition of the merits of natural gas as an ashless fuel of high heat value, definite conclusions as to the adequacy of its supply, and surveys of potential demand in areas under consideration, were combined with the engineering ability and financial support necessary for these new accomplishments in transportation. Much of this construction has been so recently completed that its full effect is not yet apparent.

During 1928 more than 1 trillion 568 billion cubic feet of natural gas was produced and delivered to consumers an increase of 8 per cent over corresponding figures for 1927. Of the 1928 distribution, 36.6 per cent was consumed as a fuel in oil-field operations and 7.3 per cent for fuel needs at petroleum refineries, making a total of nearly 44 per cent consumed within the oil industry. Manufac-

ing and industrial plants utilized 19.5 per cent of the total, 4.9 per cent was consumed in the generation of electric power at public-utility plants, and 11.2 per cent was used in the manufacture of carbon black. A total of 79.5 per cent was used in industry and 20.5 per cent for domestic purposes.

The quantity of natural gas produced and delivered to consumers during 1929 reached a total of approximately 1 trillion 800 billion cubic feet, an increase of about 15 per cent over 1928. Natural-gas production in Louisiana, the point of origin for several of the longer interstate lines completed during this past year, increased nearly 30,000,000,000 cubic feet, or approximately 13 per cent, over 1928. Withdrawals of natural gas from high-pressure wells in Texas during 1929 were approximately 18 per cent greater than in 1928. Increased production was reported also for Oklahoma, and in California the 1929 natural-gas production was substantially greater than during the preceding year.

Although sufficient information is not yet available to determine all trends in consumption, some tendencies are apparent. The consumption of natural gas as a fuel in the generation of electric power at public-utility plants reached a total of 112,847,040,000 cubic feet, as compared with 77,173,517,000 cubic feet during 1928, an increase of 46 per cent. Purchases of natural gas for distribution by 98 public-utility gas companies during 1929 were 49.7 per cent greater than in 1928. Preliminary data from trade sources indicate that the production of carbon black during 1929 was approximately 45 per cent more than in 1928, from which it may be inferred that the natural-gas

consumption in the manufacture of carbon black increased proportionately. This increased carbon black production was largely confined to Texas. Preliminary information from State sources indicates that 200,000,000,000 cubic feet of residue gas was used in carbon-black manufacture in Texas during 1929, as compared with approximately 63,000,000,000 during 1928.

The number of communities in Texas served with natural gas has increased from 82 at the close of 1926 to 490 at the end of 1929. In Oklahoma 285 cities and towns were receiving natural-gas service at the close of 1929, as compared with 254 at the beginning of the year. The pipe line from Wyoming to Ogden and Salt Lake City added 13 communities in Utah to those served with natural gas. It is reported that 20 cities and towns in Arkansas and Missouri were included in the natural-gas service afforded by the pipe line completed from northern Louisiana to the St. Louis industrial district. The recently completed pipe line from Louisiana across Mississippi, Alabama, and Georgia is planned to serve 40 communities in these three States.

Prior to 1927, transportation of natural gas over a distance of 250 miles was regarded as an outstanding engineering accomplishment. In July, 1927, a line 20 inches in diameter was started at Pampa, Gray County, Tex., to connect the gas fields of the Texas Panhandle with Kansas City, Mo. The whole system, when completed in September, 1928, was 382 miles in length and was estimated to be capable of handling a maximum peak-load delivery of 250,000,000 cubic feet daily. In December, 1927, another long natural-gas transmission line was

started. This line, 22 inches in diameter, was laid from the Amarillo field, in the Texas Panhandle, to Denver, Colo., a distance of 340 miles, and was referred to as one of the greatest enterprises undertaken in the gas industry. During 1929 this system was extended eastward from Pueblo to several towns within a distance of approximately 50 miles, and plans are reported under consideration to extend it to other communities nearer the Kansas line.

The completion of these lines was followed closely by other developments. Some major pipe-line projects recently completed are:

1. Memphis has been supplied with natural gas from Louisiana since December 28, 1928.

2. New Orleans is served with natural gas through an extension of the pipe line which formerly terminated at Baton Rouge.

3. The St. Louis industrial district is supplied with natural gas through a 450-mile pipe line from Louisiana.

4. A 420-mile pipe line has been built across Mississippi, Alabama, and Georgia to deliver natural gas from Louisiana to Birmingham, Ala., Atlanta, Ga., and other communities in these States.

5. A 250-mile pipe line has been laid to San Francisco from the Buttonwillow and Kettleman Hills areas in southern California, and is being paralleled by a second line.

6. Salt Lake City and Ogden, Utah., are served with natural gas from Baxter Basin, Hiawatha, and Clay Basin fields in Colorado, Wyoming, and Utah.

7. Monterrey, Mexico, is served with natural gas from the Jennings field, Tex., through a pipe line crossing the international border at Roma, Tex.

8. Approximately 200 miles of pipe line carry natural gas from the Jal area, Lea County, N. Mex., to El Paso, Tex.

Projects under recent consideration tending to extend areas served with natural gas, although actual construction has not been started, include a 950-mile pipe line from the Amarillo field, in Texas, to Chicago; the extension of the present pipe line to San Francisco northwards to Oregon and Washington; the extension of the pipe-line system in the Rocky Mountain district to include Butte, Anaconda, and other communities; the conversion of oil pipe lines to the transport of natural gas; and the construction of necessary additions to serve mixed gas to certain cities along the Atlantic seaboard.

Reviewing this list of natural-gas and anticipating the building of still longer lines, the question naturally arises as to what new conditions have made possible the building of natural-gas distributing systems extending farther and farther from the gas fields.

The subject is one in which both engineering and economic factors are involved. Every natural-gas distribution project requires the detailed consideration of at least three major factors, namely:

1. Assured supplies of gas for long-time periods.
2. Assured markets.
3. Costs of construction and operation.

In so far as the decision to undertake a natural-gas distribution project is concerned, the first two items have relatively more weight than the third. In other words, cheaper pipe-line construction, made possible by the use of improved methods and the application of advanced engineering science, is only one of several items in establishing the first cost of the project; it is essential to have an assured gas reserve, capable of supplying a market over a long-time period, in order to attract the necessary capital to finance the project.

Many long natural-gas transmission lines probably would have been built to connect newly discovered fields with marketing centers even with higher construction costs, for the size and nature of the markets and the extended life of proved reserves would assure the amortization of investment in a connecting pipe line long before the natural reservoirs were depleted. Improved methods of pipe-line construction have decreased the cost of the long gas lines built during the past several years. The use of large-diameter pipe made of high-carbon steel with greater ultimate strength, and the handling of gas at high pressures, are developments of outstanding importance in long-distance transmission.

With the advent of conditions requiring a pipe line to deliver maximum peak load of or exceeding 250,000,000 cubic feet per day, the important problem of design of a natural gas pipe-line project includes the study of:

1. Size and weight of line and working pressures.

2. The number and size of compressor stations, together with the desirable compression ratios.

3. Relationship between investment and operating costs with the view of obtaining a properly balanced and economical system.

The principal item of cost in a pipe-line project is the cost of the pipe itself. The cost of the pipe varies directly as the weight, which in turn varies directly as the diameter multiplied by the thickness. With increasing diameter, the thickness of the pipe must be increased proportionately to withstand the same pressure. Because an increase in the diameter of pipe increases the capacity more rapidly than the corresponding increase in cost, the general tendency has been to use pipe of sufficiently large diameter to deliver the capacity required at pressure up to 350 or 400 pounds per square inch. However, the possible economy which may be effected in gas transportation through lines of smaller diameters and greater wall thickness under pressures as high as 1,500 pounds per square inch is being considered at the present time. It has been suggested that while the costs per lineal foot of line may be more for this type of construction, the cost per cubic foot of natural gas delivered may be less.

Several gas companies have reduced the cost of their pipe-line construction materially by using so-called telescope lines. These lines are made up of sections of pipe of different diameters, the diameter increasing in the direction of flow, as the pressure decreases. For example, where a 16-inch line is required, its equivalent may be built with 14, 16, and 18 inch pipe; or a line of uniform diameter may be built with the weight of pipe decreasing in the direction of flow so that pipe with thinner walls is used where the pressures are lower. Telescopic design

of pipe lines has the effect of reducing the total weight of the pipe and consequently the cost. Telescopic lines should be especially economical where high initial pressures exist and where there are long distances between compressor stations. The efficiency of flow through telescopic lines is being studied by Federal and industrial agencies to determine the advantage in amount of gas handled in these lines as compared with lines of constant diameter.

The increasing use of better welding methods is changing the type of pipe-line construction and effecting economies. In the manufacture of pipe, automatically controlled process welding by the electric-arc method has made it possible to fulfill some of the requirements of high-pressure pipe design. Extensive use of oxyacetylene welding in the field has marked the passing of large, heavy, cast-iron fittings. The all-welded and forged-steel flanged manifold is a good example of the improvement that has come about through the use of welding in place of cast-iron fittings.

Further economies in pipe-line construction have resulted from the use of longer lengths of pipe for main trunk-line work. With the generally accepted use of welding on trunk lines, the demand for 40-foot lengths of plain-end pipe has increased. Forty-foot lengths effect a considerable saving in construction costs, and the trend is definitely toward the use of 40-foot lengths, or possibly longer, for welded trunk lines.

Only recently electric-arc welding has come into use for the welding of pipe lines in the field. Advocates of the electric-arc method believe that it will reduce construction costs and have other advantages. Progress is being made

in the development of automatic welding processes for field service. When perfected, these methods will tend to reduce the cost and increase the rate of construction.

Machinery has largely replaced the older hand methods of pipe-line construction. Costs have been lowered by laying, hauling, hoisting, and handling pipe with machines and tractors especially designed for this work.

Corrosion is an important factor in determining the cost of a pipe line. The amount of expenditure warranted for protective pipe coatings depends upon the nature of the soil in which the pipe is to be laid and the relative corrosive effects of the soil. The economic value of good pipe coatings has become more and more appreciated during the past few years. Many operators are using costly pipe coatings, and experience has proved that such protections are economically justified. Frequently the life of a pipe line in the ground may be prolonged 50 per cent by the application of proper pipe coating.

Until a few years ago little or no attention was given to the economy possible with a gas-tight transmission system. Now pipe lines are given careful leakage tests. Also, provision is made for the removal of condensates, sands, and other foreign material which would decrease the capacity of lines and thus increase the compression costs.

### Need of Full Utilization of Gas.

The expansion of facilities for the distributing natural gas has demonstrated the public demand for this best of fuels. By virtue of its convenience as a domestic fuel and its economy as an industrial fuel, natural gas is winning

recognition in communities and districts where it had been unobtainable until technical skill combined with courage on the part of the public utilities made its wide distribution a reality. With this increased and growing market for natural gas, not only the gas produced from the so-called dry-gas reservoirs is in demand but there is a growing realization of the commercial value of the gas delivered to the surface in conjunction with the production of oil. There has also been a widespread realization of the importance of natural gas in its function as a propulsive agent in the production of oil. So it is that natural gas is now coming into its own as an item of large significance in the balance sheet of the oil operator.

The oil industry now sees substantial profits in this fuel of high heating value which was previously disregarded. Attention had been repeatedly called to the enormous waste involved in the escape of gas into the air, but since above-ground storage of natural gas is plainly impracticable from the standpoint of cost, many executives, who thought in terms of oil, regarded escaping gas as unavoidable waste. Now that this natural resource, produced with the oil, has taken on a commodity value at the well as a result of long-distance pipe lines, opinions and policies have changed. Moreover, production engineers are now pointing out the even great importance of gas as the most efficient agent in extracting oil from the ground, with the result that it is realized that the prevention of the escape of gas is highly desirable in the practical business of producing oil.

Yet the volume of gas that escapes into the air is not commonly appreciated by many owners or operators, or,

if realized, the large quantities thus lost frequently are taken as indicative of inexhaustible reserves rather than of wasted wealth. The latest legislative effort to prevent this waste is the California gas law, which has been described as based on good technology and good economics. As reported by the gas administrator of that State, the amount of natural gas blown to the air during the latter part of 1929 was nearly a billion feet a day, or more than was being used in the entire State, and in some individual oil fields the ratio of waste to use is even now much worse. Nor is California the only State in which the waste of gas is expressed by large figures.

The economic arguments for stopping this waste and enforcing full utilization relate to present profits of the producers and future benefits of the consumers. In the Kettleman Hills oil field in California the gas from the few wells now producing, even without including its gasoline content, is worth more, at present field prices, than the high-grade oil this gas brings to the surface. Yet with the traditions of the industry influencing current thought, the output of oil is the chief consideration, and while earnest efforts are being made at Kettleman Hills to hold back oil production to the requirements of market demand, too little thought is given to the State's contention that "the blowing, release, or escape of natural gas into the air shall be prima facie evidence of unreasonable waste." Nor is there seemingly any recognition of the obvious fact that for the nearly 350,000,000 feet of gas now escaping daily, because less than 20 per cent of the present flow from this source can be marketed, the operators and owners receive no return now or at any time.

Gas with a value, at the well, of millions of dollars a year is being blown into the air, an invisible but actual leak.

This blindness to the immensity of the present waste can perhaps be cleared upon by a simple analysis of the statement of the California gas administrator referred to above. If from July to October, in 1929, the amount of blown gas in California actually exceeded the amount utilized, it must follow that at some time in the future the industrial and domestic users of gas will be without gas four months sooner, at the present rate of consumption, than would be the case if this four months' supply had not gone to waste. On the public side, therefore, there is this definite and quantitative relation between waste now and shortage in the future.

## Appendix E.

### Report III of the Federal Oil Conservation Board. Existing Petroleum Situation in the United States.

Washington, February 25, 1929.

*To the President of the United States:*

Supplementing its reports of September, 1926, and January, 1928, the the Federal Oil Conservation Board again reviews briefly the existing petroleum situation in the United States. The report now submitted sets forth in broad outline the changes that have taken place in the conduct of a great productive industry and records the progress made in the four years since you placed upon this Conservation Board the responsibility of promoting cooperation between the Government and the oil industry.

* * * * * * * *

Legislative Proposals.

Immediately after the issue of this board's second report, a year ago, the results of a legal study of the situation were reported by a committee of nine representing the Federal Government, the petroleum industry, and the mineral law section of the American Bar Association. This committee of nine was appointed by the Federal Oil Conservation Board and confined its recommendations to Federal legislation. The specific bill thus recommended as a conservation measure would provide, in certain contingencies, relief of oil operators from the provisions of the Federal antitrust acts, with proper safeguards in the public interest. The report of this committee, which also urged similar legislation by the oil-producing States, was

referred by this board to the governors of those States; this proposal now rests with them. That report appears as Appendix A (p. 9).

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APPENDIX A.

COMMITTEE OF NINE.

January 28, 1928.

HON. HUBERT WORK,

*Chairman Federal Oil Conservation Board.*

Sir: The committee of nine, appointed by your board to consider a legislative program for the conservation of gas and petroleum resources, begs to report as follows:

* * * * * * * *

Privately Owned Lands.

We take it that true conservation does not mean the withholding from present use of the Nation's natural resources. It does mean that those resources should be drawn upon without waste and in orderly response to the economic needs of the country. We have devoted attention to ascertaining to what extent and in what manner waste occurs in the production and use of oil, and to how and why the production of oil is not in orderly response to the country's economic demand for it.

* * * * * * * *

The primary and most important cause, both of the failure to recover the full recoverable proportion of the oil content and of production at recurring periods out of all proportion to the demand, is not far to seek and is the same. It consists in the law governing the right of the owner of land to recover oil from it. The law is that

the owner of land has the right to recover from his land all the oil that can be produced therefrom, regardless of whether that oil was originally in place in his ground or has been caused to flow from the ground of others by his action in opening and operating a well on his property. There is no property, in the strict sense, in the oil until it is recovered any more than there is in underground water, and the oil belongs to him who first gets it. The result is that when an oil field is once opened, it is a race between all the owners in the field to recover all each can. It is a race in which they must take part, willy-nilly, or else lose what otherwise they might obtain. It is a race which can be avoided only by the joint action of every one in the field.

* * * * * * * *

The intensity of the race is increased by the function which natural gas plays in the process of production. That function is the subject of a most illuminating report by the technical subcommittee of the American Petroleum Institute gas conservation committee, made up of leading petroleum engineers of the country. It is so valuable a contribution that we append this report as Appendix II (p. 19). Among other things, the report says:

"The data show conclusively that the conservation and efficient utilization of gas are of paramount importance in the conservation and economical production of oil. Gas dissolved in oil makes the oil more fluid, and more capable of movement through the pore spaces of the reservoir rock to the well, the energy stored in the same gas is the chief force behind that movement. The more gas the easier the oil moves and the greater the force available

to move it. To dissipate gas from an oil sand is to lessen the propulsive force and increase the need for it. The energy and solution values of oil-field gas are of tremendous importance. The proper utilization of gas results in greater and more orderly oil recovery at lower cost. The data show that the way to use gas to the best advantage is to use it in its original state, and that the conditions in a sand, once destroyed, can never be completely restored."

Again the report says:

"The data show finally that many, probably most of the best methods for gas utilization can be practiced advantageously only when they can be applied systematically to a whole field; that competitive drilling in individual fields almost inevitably leads to gas waste and lessened ultimate oil production; and that either complete cooperation or unit operation is the ideal operating condition for the conservation of both gas and oil."

Since gas is the most important factor in detaching the oil from the sands and bringing it to the well, and in case of flowing wells to the surface, and since also the oil content is common to the whole field—using "field" in the sense of a single deposit or pool—the release of gas through one well affects all other wells in the same field.

Closely connected with the matter of cooperative development and operation of oil pools is that of conserving the gas content. The waste of gas in actual practice has been great, both in the failure to maintain the gas pressure for oil-producing purposes, and in the failure to put the gas to the valuable economic uses of which it is capable. Enormous quanties of gas have been simply wasted into the open air or burned. We have given particular consideration to this phase of the conservation problem. We are greed that in general the waste of gas

should be forbidden by law. We likewise agreed that suitable legislation to this end is the most important affirmative step to compel conservation that can be taken. Such legislation, if properly devised, will, we believe, not only prevent waste existing at the present time, but will have a decided effect in inducing agreements for the cooperative development and operation of oil fields, and such cooperative development and operation constitutes, we believe, the most important means of fully utilizing and conserving in the true sense our oil resources.

But we are unable for the present to determine just the form that such legislation should take. Ill-advised legislation, no matter how well intended, might do great injury and great injustice; for example, we doubt exceedingly the wisdom of legislation which would simply forbid without any exception the escape of any gas not put to beneficial use after leaving the well. Conditions in the various fields differ so greatly, and actual development has proceeded so far under present practices, that an inflexible rule such as that just mentioned might well mean that some fields would have to be shut down. Any measure compelling conservation will affect some interests adversely, and the mere fact that it does so is not a sufficient reason for not adopting it. But if the measure is too drastic as applied to existing conditions and is so harsh as to work grave injustice, it defeats itself in actual operation and runs the danger at least of being held to be unconstitutional.

The legislation furthermore is legislation which must be adopted by the States. In our judgment, legislation regulating or forbidding the waste of natural gas is primarily within the police powers of the individual States, and at least under present conditions not within the powers of the Federal Government.

The preparation of proper legislation respecting the waste of gas is one that requires a study, both of present

existing conditions and of the existing laws of the oil-producing States. That study we have not been able to make to a sufficient extent to satisfy us as to the exact nature of the legislation which should be recommended. So far as this particular point is concerned, we repeat our statement that legislation forbidding, as a general rule, the waste of gas is vitally necessary, and we recommend that further study be given in the immediate future to the form such legislation should take, and that when that study has been completed definite recommendations on the subject be made to the oil producing States. The legislatures of those States will not meet in regular session until next year, so that there is time for such study before action can be had. We have thought it well, however, to make our report without waiting for the study required on this particular point, as Congress is in session and there is an immediate need for action by it in the particulars we have already mentioned and the further particulars to which we will next refer.

* * * * * * * *

## Appendix II.

### The Conservation of Gas.

Report of the Technical Sub-Committee of the American Petroleum Institute Gas Conservation Committee, Chicago, Ill., December 2, 1927.

### Introduction and Conclusions.

This report is a summary of the voluminous data submitted, in detailed reports, in committee discussions, and in a three-day hearing, at Ponca City, by more than 100

production engineers, geologists, chemists, and physicists regarding the importance of natural gas in oil production and the means for utilizing it most efficiently. These men come from all the important fields of the United States, and represent 3 Federal agencies, 9 universities, the National Research Council, 34 oil companies, and a number of individual activities.

The data show conclusively that the conservation and efficient utilization of gas are of paramount importance in the conservation and economical production of oil. Gas dissolved in oil makes the oil more fluid, and more capable of movement through the pore spaces of the reservoir rock to the well, the energy stored in the same gas is the chief force behind that movement. The more gas the easier the oil moves and the greater the force available to move it. To dissipate gas from an oil sand is to lessen the propulsive force and increase the need of it. The energy and solution values of oil-field gas are of tremendous importance. The proper utilization of gas results in greater and more orderly oil recovery at lower cost.

The data show that the way to use gas to the best advantage is to use it in its original state, and that the conditions in a sand, once destroyed, can never be completely restored; but they show also that the injection of gases into many fields has had highly beneficial effects.

The data show that many methods are of value in conserving gas and utilizing it efficiently, that the effectiveness of each method varies in different fields and with different wells, and that no single method or group of methods can be universally applied. Each well should be

studied as an individual problem and to it should be applied the combination of methods found to give the best results.

The data show finally that many, probably most, of the best methods for gas utilization can be practiced advantageously only when they can be applied systematically to a whole field; that competitive drilling in fields almost inevitably leads to gas waste and lessened ultimate oil production; and that either complete cooperation or unit operation is the ideal operating condition for the conservation of both gas and oil.

## Occurrence of Oil and Gas.

Oil and gas originate from various organic materials deposited in sediments and converted into oil and gas by heat and pressure during geologic processes. Differences in the character of the organic material, differences in the amount and duration of the heat and pressure, and differences in the chemical environment result in hydrocarbons ranging from the lightest gas to the heaviest asphalt.

These oils and gases are found concentrated on rock-folds known as geologic structures, in reservoir rocks of greater or less porosity, thickness, and homogeneity. The reservoir rock may be, for example, a single sandstone bed a few feet thick and of uniform porosity, a porous lentil in a limestone, or a great body of poorly consolidated sediments made up of relatively thin and often lenticular beds of pervious sand and impervious shale. The great variety of reservoir rocks gives an equal variety of production conditions. The reservoir pressure in the homogeneous sandstone is likely to be the

same throughout the field; in the limestone bed variations in porosity may induce variations in the pressure; in the alternating sediments the reservoir pressure, the character of the hydrocarbons, and the water conditions may be different in each sandstone layer and in every part of the field. Whatever the character of the reservoir it is commonly referred to as a "sand."

Some productive sands contain oil and gas; some contain gas alone; oil sands without gas are practically unknown. This summary is concerned only with reservoir rocks carrying oil and greater or less amounts of gas.

Gas may be present in an oil sand in one or all of four phases: (a) free; (b) dissolved in the oil; (c) as a liquid, becoming a gas when the pressure is lowered; and (d) adhering to the surfaces or interfaces between the gases and the liquids, the fluids and the solids in a process known as absorption. Each of these phases has its bearing on the efficient utilization of the gas.

### The Importance of Gas in Oil Production.

Natural gas in most oil sands is the most important agent in the recovery of oil. In some fields water is the all important expulsive force and in some gravity assists in production, but in most fields water and gravity are of minor importance when compared to the work of gas.

The gas may, and as far as possible should, be utilized as "original gas" before being exhausted from the sand, but when the original gas has been wholly or partly dissipated gas may advantageously be injected.

### Value of Original Gas.

Gas in an oil sand should be looked on primarily as a source of energy rather than as a substance. This stored

energy is the prime motive force for the extraction of the oil from the reservoir. It drives the oil through the minute pore spaces of the reservoir rock to the well and lifts or helps to lift it to the surface.

Gas has a second and almost equally important value—its value in increasing the fluidity of the oil. As already noted, part of the gas in an oil sand may be in liquid form; part may be dissolved in the oil. The amount that may be dissolved depends upon the character of the oil and the character of the gas and is proportional to the temperature and the pressure.

The greater the amount of dissolved and liquid gas in an oil the lighter the oil, the less viscous, and the lower its surface tension. Specific gravity, viscosity, and surface tension of the oil are all lessened by the solution of the gas, and as these are lessened the mobility of the oil is increased. Rendered more fluid by the gas, the oil can pass through the intricate, tortuous, interstices of the reservoir and find its way to the area of lower pressure at the well. Greater fluidity, greater mobility, greater ease of movement—these represent the solution value of gas in oil.

It will be noted how these two values supplement one another. The gas makes the oil easier to move; the energy in the gas moves it. These two properties of gas are of prime importance in the production of oil.

When a well penetrates a petroleum reservoir theretofore untouched gas pressure is released about the well and oil and gas begin to flow through the reservoir spaces toward the point of lowered pressure. As the fluid moves toward the well there is a progressive drop in pressure.

With the drop in pressure the free gas expands and drives the oil through the sand; the dissolved gas comes out of solution and becomes free gas; the liquefied gas vaporizes and becomes free gas; and the additional free gas also helps to drive the oil to the well. The progressive liberation of energy increases the velocity of the fluids and overcomes friction as they move through the rock voids toward the point of egress.

It is logical to assume that those winding pore channels which have the greater and more uniform cross section will carry a more mobile fluid, a fluid with a greater proportion of gas, than the other channels, and that this gas portion is augmented by distillation from neighboring channels. The natural gas in endeavoring to escape from the reservoir in such a way as to reduce the stored energy attempts to clear those larger and more uniform pore channels of petroleum, which, when cleared, will permit the free egress of the remaining gas to and out of the well, leaving a maximum of petroleum in the reservoir. If the pressure is too rapidly reduced by permitting too rapid escape of gas from the well the proportion of oil left in the reservoir is increased.

As the pressure is lowered and the dissolved and liquid gas leave the oil the oil becomes more viscous and increasingly difficult to move, and this augments the tendency to leave more oil in the reservoir if the pressure is too rapidly exhausted.

As the production declines the proportion of gas produced with the oil—the gas-oil ratio—increases, and the gas energy declines below the point necessary to flow the well. Thus the flush or flowing period of the field passes.

As the field declines pressures are lower than during the flush period and oil is not so plentiful or so mobile. Gradually oil accumulates in the bottom of the well and the surrounding sand and obstructs the passage of the gas. Pressure is built up behind the oil and when this pressure is great enough the well again flows, the sand near the well is again depleted, and the cycle is repeated. This is the period of intermittent flow.

Finally the amount of oil reaching the well and the amount of gas and gas pressure behind it are not great enough to cause even intermittent flow. Gravity begins to play a more important part in the movement of the oil, especially if the reservoir body be thick. The oil is less mobile, all the gas energy is utilized in bringing the oil to the well, and artificial means must be employed for lifting it. The well has reached the pumping stage.

It is readily seen that throughout the well history the gas present in the oil has facilitated movement toward the well, and that, except for the part that may have been played by other forces such as water and gravity, movement has depended entirely on the gas energy.

In many fields the gas pressure has played a third important role in holding back edge or bottom water or both and preventing its encroachment into the productive parts of the sand. When the gas pressure declines below the hydrostatic head of the water, friction alone delays the water in flooding the field.

### Injected Gases.

At almost any stage of the field's depletion gas (either natural gas or some other) may be injected into the sand in an attempt partially to restore original conditions

and thus increase both the immediate and ultimate oil production. It is possible by such injection of gas to restore in part the earlier gas pressures and thus rebuild the energy value stored in the field. There is grave doubt whether the solution value of the gas can be restored.

It seems unlikely that injection of gas restores anything approximating the original conditions. The introduced gas is nearly always lacking in fractions which will liquefy at the restored pressures. The area of contact between the gas and oil is relatively small and diffusion of the gas through the oil is apparently slow. Gas is probably not re-adsorbed at the liquid-solid interfaces. Thus three of the four original phases of the gas are seemingly not recreated; the energy effect of free gas is restored, but the energy effect of the adsorbed gas and the energy and solution effects of the liquid and dissolved gases are not fully restored. Despite these facts, however, the injection of gases is one of the best methods for rejuvenating many fields. The energy effect of the free gas is alone an important asset.

As to the relative values of various gases, the injection of natural gas, preferably of the same composition as that taken from the reservoir, would go farthest toward restoring original conditions of energy and solution. The introduction of identical gas is difficult, however, because the compression of the gas for injection denudes it of some of those constituents which would otherwise liquefy in the reservoir and increase the mobility of the oil.

There is some evidence that the driving effect of air is at least as great as that of gas. Air oxidizes some oils

and makes them more viscous, and hence more difficult to move through the pores. Under certain conditions the air forms explosive mixtures unsafe for fuel purposes, and in many fields, especially those in which sulphur is present, it increases corrosion of the casing and tubing.

Flue gas resulting from the combustion of natural gas may be treated and used for injection purposes. It is free from most of the corrosion and explosive disadvantages of air, but its effect on the viscosity is about the same.

As already said, the injection of gases into depleted sands is in many fields an effective method of increasing production, but it can not compare in effectiveness with the efficient utilization of the original gas.

The Efficient Utilization of Gas in Oil Production.

The purpose of the efficient utilization of gas in oil production is to produce the most oil at the least cost in the most orderly manner. The most efficient method is the one making the greatest effective use of the energy and solution values of the gas. It is the method that will produce the greatest amount of oil with the minimum expenditure of gas energy. The cubic feet of gas produced with each barrel of oil, known as the gas-oil ratio, is a working index, but not an infallible index, of the efficiency of any method; in general, the lower the ratio the greater the efficiency.

No one method can be prescribed; the method most effective with one well may fail with another. The variations in thickness and porosity of reservoir sands, in character of gas and oil, in hydrostatic head, in gas pressure,

and many other factors necessitate the study of each field and even of each individual well. This is the province of the production engineer. The methods herein briefly discussed are those that have given favorable results in various places and under various conditions.

## Methods During Development.

Careful study should be given to the spacing of wells. Too wide spacing gives the gas too great a distance to propel the oil, and results in inadequate drainage and lower recovery of oil per acre. It is obvious, of course, that too close spacing gives an excessive development cost per acre.

The timing of wells should also be given consideration. The ideal method of utilizing gas energy to the fullest extent would be to drill all the wells necessary to drain a structure, cap each well brought in until the boundaries of the field are determined, and then put all wells on production at the same time. This is possible, of course, only when an entire structure is handled under a single development and production program.

Careful thought should also be given other drilling problems, such as the depth to which the reservoir should be penetrated; the complete cleaning of mud from the face of the sand, the placing of shots so as to avoid the shattering of impervious beds above or below the reservoir; and the setting of casing to separate all oil, gas, and water-bearing strata and, when gas is present in the same reservoir rock above the oil, to confine it so that its energy is directed downward to and through the oil rather than laterally to the well.

## Pressure Control.

The retention of fluidity and energy and the production of the greatest volume of oil with the smallest reduction in rock pressure are both accomplished by the proper adjustment of the amount of pressure held on the sand. This is done by regulating the flow stream from the well in such a way as to regulate the fluid pressure on the exposed face of the reservoir in the well.

The methods which have been found effective in various fields are the tubing of wells, as early in their life as conditions allow, instead of permitting them to flow through the casing; the use of flow beans, the regulation of lengths and sizes of flow lines; the regulation of trap pressures; stop-cocking, or alternately closing and opening a well to maintain an intermittent flow; and the use of the air-gas lift, which alters the fluid pressure on the face of the reservoir formation and simultaneously alters the fluidity, specific gravity, and energy in the fluid column in the well so that more efficient flow may be maintained. Each of these methods has been found valuable in various places and under various conditions, but no one of them is valuable under all conditions. As has already been emphasized, each fluid, each lease, and each well must be given individual study.

Wells which have too high a gas-oil ratio and refuse to respond to treatment should, whenever possible, be shut in to conserve the gas pressure. In certain cases this has been found to increase the production of nearby wells by more than the amount of the former production of the shut-in wells, and the ultimate yield of the area should be considerably benefited. This is also, of course, a

practice to be adopted only under unit or cooperative operation of the field.

In this class fall fields which have an area of free gas on top of the structure. The dissipation of this free gas not only deprives the field of a great energy value available to produce the oil but draws the oil into the free gas area and disseminates it through previously dry sand from which much of it may never be recovered. The shuting in of the gas wells confines the oil to its original boundaries, permits the utilization of the energy and solution values of the gas, and defers the day of water encroachment.

## Injection of Gases.

The general effects of injecting gas, air, or flue gas into a wholly or partially depleted reservoir have already been discussed. The three methods generally considered are pressure maintenance, repressuring, and gas drive. In practice the three are not always distinguishable.

In repressuring gas is introduced into the sand under pressure through certain wells while all other wells are shut in. The method has certain theoretical advantages and certain economic disadvantages, and has not been adequately tested.

In pressure maintenance and the gas, drive, gas—natural gas, air, or flue gas—is introduced into the sand through "key" or "input" wells, and oil and gas are produced from surrounding wells. The injection of gas should be started as early in the life of the field as production conditions will permit, and the gas injection and the maintenance of back pressure on the other wells should

be so regulated as to maintain the original gas pressure as nearly as possible.

In certain Texas and Louisiana fields gas drive is estimated to have increased the ultimate recovery thirty-five to sixty per cent, with decided increases in current production.

Gas Conservation and Unit Operation.

Most of the methods discussed above can not be effectively applied in fields in which the leases are in diverse ownership and competitive operating conditions prevail. The effectiveness of most of them depends on simultaneous application to the whole of a productive area. Proper well spacing, proper well timing, pressure control, pressure restoration, gas drive—only in rare cases can these methods be adopted by the competitive operator in a field. Unless a field is operated as a unit, whether by cooperation or control, there is little chance of holding down the gas-oil ratio, utilizing the energy and solution values of the gas, making the gas do the maximum work in the production of oil, or producing the greatest total amount of oil at the smallest cost.

EARL OLIVER,
*Chairman.*

G. C. GESTER,
*Pacific Coast Region.*

W. P. HASEMAN,
*Kansas-Oklahoma Region.*

FRED E. WOOD,
*Rocky Mountain Region.*

JOHN R. SUMAN,
*Texas-Louisiana Region.*

MAX W. BALL,
*Secretary.*

Chicago, Ill., December 2, 1927.

# APPENDIX F

# The New International Year Book, 1929.

## SUMMARY OF NATURAL GAS STATISTICS, 1928

| | Production | | | | Consumption | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Domestic | | Industrial | | | | |
| | Quantity (Millions of cubic feet) | Estimated average value at wells per M cu. ft. (cents) | Average value at points of consumption per M cu. ft. (cents) | Thousands of consumers | Consumption (Millions of cubic feet) | Average value at points of consumption per M cu. ft. (cents) | Field drilling, pumping, operating gasoline plants, etc. Millions of cubic feet. | Field drilling, pumping, operating gasoline plants, etc. Value at points of consumption (Thousands of dollars) | For fuel at petroleum refineries (Millions of cubic feet) | In manufacture of carbon black Millions of cubic feet (Estimated) | In manufacture of carbon black Value at points of consumption (Thousands of dollars) |
| Arkansas | 20,235 | 6.4 | 17.6 | 62 | 6,785 | 48.4 | 13,728 | $ 1,086 | 3,737 | ..... | $.... |
| California | 246,215 | 8.8 | 23.0 | 769 | 37,702 | 87.5 | 149,307 | 13,273 | 17,403 | ..... | .... |
| Colorado | 2,931 | 10.0 | 26.8 | 69 | 629 | 110.8 | 1,180 | 118 | (b) | ..... | .... |
| Illinois | 3,051 | 10.0 | 11.8 | 12 | 52 | 88.5 | 2,931 | 295 | ..... | ..... | .... |
| Indiana | 1,290 | 34.7 | 49.5 | 16 | 791 | 61.9 | 85 | 9 | ..... | ..... | .... |
| Kansas | 45,644 | 6.7 | 31.0 | 160 | 12,008 | 65.6 | 14,782 | 1,380 | 7,171 | ..... | .... |
| Kentucky | 15,383 | 10.9 | 34.8 | 141 | 10,753 | 45.3 | 968 | 112 | ..... | 218 | 22 |
| Louisiana | 227,821 | 3.3 | 8.9 | 126 | 6,127 | 45.3 | 26,004 | 1,211 | 22,034 | 104,670 | 2,473 |
| Michigan | 469 | 8.5 | 31.8 | 10 | 60 | 150.0 | 99 | 9 | ..... | ..... | .... |
| Missouri | 360 | 8.6 | 60.3 | 99 | 6,129 | 82.8 | 8 | 1 | ..... | ..... | .... |
| Montana | 6,039 | 4.2 | 21.0 | 13 | 2,346 | 43.1 | 1,116 | 106 | (b) | 1,760 | 35 |
| New Mexico | 838 | 5.1 | 7.9 | 1 | 47 | 48.9 | 772 | 39 | (b) | ..... | .... |
| New York | 7,224 | 32.3 | 66.8 | 242 | 16,391 | 68.5 | 716 | 238 | ..... | ..... | .... |
| Ohio | 56,341 | 18.0 | 57.0 | 1,192 | 88,511 | 62.7 | 3,850 | 1,406 | ..... | ..... | .... |
| Oklahoma | 320,861 | 6.5 | 14.8 | 216 | 23,185 | 50.9 | 205,159 | 19,474 | 16,184 | ..... | .... |
| Pennsylvania | 99,466 | 29.3 | 48.7 | 615 | 52,971 | 61.2 | 6,606 | 2,229 | 1,173 | ..... | .... |
| South Dakota | 214 | 8.9 | 99.1 | 2 | 214 | 99.1 | ..... | ..... | ..... | ..... | .... |
| Texas | 301,990 | 3.4 | 17.0 | 420 | 27,284 | 67.1 | 106,034 | 12,749 | 29,641 | 62,749 | 1,576 |
| Utah | 1,105 | 2.0 | 2.0 | .... | ..... | ... | ..... | ..... | ..... | (c) | (c) |
| West Virginia | 163,018 | 17.6 | 44.3 | 172 | 25,407 | 33.0 | 16,876 | 3,767 | 1,519 | 494 | 69 |
| Wyoming | 47,490 | 3.5 | 7.4 | 13 | 2,729 | 39.2 | 22,473 | 853 | 15,706 | 5,246 | 146 |
| Other | 154 | 8.4 | 29.9 | 16 | 756 | 81.0 | 4 | 1 | 382 | ..... | .... |
| Total, 1928 | 1,568,139 | 8.9 | 23.2 | 4,366 | 320,877 | 62.0 | 573,698 | 58,356 | 114,950 | 175,137 | 4,321 |
| Total, 1927 | 1,445,428 | 8.8 | 22.0 | 3,984 | 296,036 | 60.8 | 549,455 | 38,912 | 123,395 | 144,087 | 4,064 |

[a] Includes value of natural gas used at refineries. [b] Included under "Other." [c] Included with Wyoming.

# APPENDIX F

# The New International Year Book, 1929.

## SUMMARY OF NATURAL GAS STATISTICS, 1928

| Production | | Consumption | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Domestic | | Industrial | | | | | | | |
| | | | | | | | In manufacture of carbon black | | Other industrial | | |
| Estimated average value at wells per M cu. ft. (cents) | Average value at points of consumption per M cu. ft. (cents) | Thousands of consumers | Consumption (Millions of cubic feet) | Average value at points of consumption per M cu. ft. (cents) | Field drilling, pumping, operating gasoline plants, etc. Millions of cubic feet. | Field drilling, pumping, operating gasoline plants, etc. Value at points of consumption (Thousands of dollars) | For fuel at petroleum refineries (Millions of cubic feet) | Millions of cubic feet (Estimated) | Value at points of consumption (Thousands of dollars) | Millions of cubic feet | Value at points of consumption (Thousands of dollars) [a] |
| 6.4 | 17.6 | 62 | 6,785 | 48.4 | 13,728 | $ 1,086 | 3,737 | ..... | $.... | 13,513 | $ 2,280 |
| 8.8 | 23.0 | 769 | 37,702 | 87.5 | 149,307 | 13,273 | 17,403 | ..... | .... | 41,803 | 10,435 |
| 10.0 | 26.8 | 69 | 629 | 110.8 | 1,180 | 118 | (b) | ..... | .... | 4,507 | 1,032 |
| 10.0 | 11.8 | 12 | 52 | 88.5 | 2,931 | 295 | ..... | ..... | .... | 68 | 19 |
| 34.7 | 49.5 | 16 | 791 | 61.9 | 85 | 9 | ..... | ..... | .... | 1,383 | 702 |
| 6.7 | 31.0 | 160 | 12,008 | 65.6 | 14,782 | 1,380 | 7,171 | ..... | .... | 38,710 | 7,755 |
| 10.9 | 34.8 | 141 | 10,753 | 45.3 | 968 | 112 | ..... | 218 | 22 | 3,863 | 1,460 |
| 3.3 | 8.9 | 126 | 6,127 | 45.3 | 26,004 | 1,211 | 22,034 | 104,670 | 2,473 | 29,920 | 6,675 |
| 8.5 | 31.8 | 10 | 60 | 150.0 | 99 | 9 | ..... | ..... | .... | 310 | 50 |
| 8.6 | 60.3 | 99 | 6,129 | 82.8 | 8 | 1 | ..... | ..... | .... | 3,629 | 827 |
| 4.2 | 21.0 | 13 | 2,346 | 43.1 | 1,116 | 106 | (b) | 1,760 | 35 | 1,692 | 373 |
| 5.1 | 7.9 | 1 | 47 | 48.9 | 772 | 39 | (b) | ..... | .... | 35 | 5 |
| 32.3 | 66.8 | 242 | 16,391 | 68.5 | 716 | 238 | ..... | ..... | .... | 811 | 508 |
| 18.0 | 57.0 | 1,192 | 88,511 | 62.7 | 3,850 | 1,406 | ..... | ..... | .... | 30,123 | 13,349 |
| 6.5 | 14.8 | 216 | 23,185 | 50.9 | 205,159 | 19,474 | 16,184 | ..... | .... | 40,805 | 7,560 |
| 29.3 | 48.7 | 615 | 52,971 | 61.2 | 6,606 | 2,229 | 1,173 | ..... | .... | 55,400 | 19,750 |
| 8.9 | 99.1 | 2 | 214 | 99.1 | ..... | ..... | ..... | ..... | .... | ..... | ..... |
| 3.4 | 17.0 | 420 | 27,284 | 67.1 | 106,034 | 12,749 | 29,641 | 62,749 | 1,576 | 93,010 | 21,640 |
| 2.0 | 2.0 | .... | ..... | ... | ..... | ..... | ..... | (c) | (c) | (c) | (c) |
| 17.6 | 44.3 | 172 | 25,407 | 33.0 | 16,876 | 3,767 | 1,519 | 494 | 69 | 21,976 | 6,401 |
| 3.5 | 7.4 | 13 | 2,729 | 39.2 | 22,473 | 853 | 15,706 | 5,246 | 146 | 1,500 | 1,242 |
| 8.4 | 29.9 | 16 | 756 | 81.0 | 4 | 1 | 382 | ..... | .... | 259 | 83 |
| 8.9 | 23.2 | 4,366 | 320,877 | 62.0 | 573,698 | 58,356 | 114,950 | 175,137 | 4,321 | 383,317 | 102,146 |
| 8.8 | 22.0 | 3,984 | 296,036 | 60.8 | 549,455 | 38,912 | 123,395 | 144,087 | 4,064 | 332,271 | 94,809 |

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used at refineries. [b] Included under "Other." [c] Included with Wyoming.

## Appendix G

Quotation from article entitled "Gas, Natural," Americana, Volume 12, p. 302, et seq., edition 1927:

"*Gas, Natural.* By recognized usage the term 'natural gas' has been restricted to the inflammable gases issuing from oil and gas reservoirs in the earth's crust—leaving the equally natural supplies of carbonic acid gas and of nitrogen to be given a more specific title. In composition, various samples of natural gas differ very considerably, but its principal component is methane, or marsh gas ($CH_4$), ranging from 81 per cent for Pennsylvania and West Virginia gas to 98 per cent in some of the gas produced in Oklahoma. * * *

"Natural gas is regarded as a form of bitumen, closely related to petroleum, maltha and asphalt. It may be mentioned in passing that the asphalt which is continually rising on the lake at Trinidad is aerated by large bubbles of natural gas. Opinion is divided as to the origin of natural gas, but the majority holds that it is the product of mineral and vegetable matter slowly decaying at a low temperature. As it is found only in sedimentary rocks, the theory prevails that it is the product of carbonaceous matter deposited with those strata, although it is quite as likely to have been formed elsewhere, finding its way into those rocks because of their porous structure. Gas, because of its natural qualities, has a tendency to make its way for long distances wherever there are hollows in which the pressure is less than its own, and only collects in considerable quantities where there is an impermeable stratum of clay or rock to prevent further movement. In these hollows it accumulates under varying pressures,

depending upon their depth below the surface, the pressure having a close relation to the weight per square inch of a column of water of the same height; from which it is argued that the pressure found in natural gas reservoirs is derived from water forcing the gas out of a lower level. Among high pressures reported have been 1,700 pounds per square inch in Green County, Pa., and 1,260 pounds more recently at Midway, Cal. * * *

"*Calorific Value.* The calorific or fuel value of natural gas varies in different localities, as the amounts of carbon and hydrogen vary. Those natural gases which contain the highest percentage of carbon give the best results. The standard used in measuring fuel values is called the British thermal unit, written B. T. U., and is the amount of heat necessary to raise the temperature of one pound of pure water 1° F. at or near 39° F., which is the temperature of the maximum density of water. As tested by this standard various samples of natural gas showed heat values ranging from 740 to 1,312 B. T. U. per cubic foot. The quantity of air necessary for the perfect combustion of natural gas varies from 10.4 to 10.8 parts of air to 1 part of natural gas. A number of tests have fully demonstrated that when ordinary care is taken in burning natural gas under boilers in actual service, 1 cubic foot of natural gas will do work equivalent to the evaporation of 1 pound of water from and at 212° F. Since 20 cubic feet of ordinary natural gas weigh 1 pound, 1 pound of natural gas will evaporate 20 pounds of water, while, under similar conditions, 1 pound of petroleum will evaporate only 16 pounds of water, and 1 pound of good coal will evaporate but 10 pounds of water; therefore 10 cubic feet of natural gas or one-half

a pound is equal to one pound of good coal. In fact, in a number of tests with a Klein or a Kirkwood burner, .87 cubic foot of natural gas has evaporated 1 pound of water from and at 212° F., which will make 17,400 cubic feet equal to one ton of good coal. The actual heating effect of natural gas as a fuel approaches much nearer the theoretical result than can be attained with coal. The price paid by the domestic consumer for natural gas varies in localities, averaging about 32 cents per 1,000 cubic feet. The consumers near the supply pay less than those farther off. Manufacturers pay less, averaging about 20 cents per 1,000 cubic feet. About 20,000 cubic feet of natural gas will equal one ton of good bituminous or anthracite coal. If we assume the average price to the domestic consumer to be 32 cents per 1,000, then $6.40 worth of gas will produce the same heating effect as one ton of good coal delivered in the bins—to which must be added the expense of shoveling it into the furnace and the removal of the ashes, as well as the inconvenience of the necessary dust and dirt which invariably accompanies a coal fire.

*"The Natural Gas Engine.* Natural gas, as applied to the internal combustion engine, has caused a complete revolution in the methods of securing power throughout the gas belt. It has in nearly all instances superseded any other source of power in pumping petroleum wells. In some instances this has been done by substituting a gas cylinder for the steam cylinder, using the same engine bed. The economy in the use of natural gas and the dispensing with the costly and troublesome boiler, with its constant attendant, has brought it into great favor for

all sources of power, from a 1 horse-power up to 4,500 horse-power engine.

"The following table gives the equivalent of natural gas and coal for both the gas and steam engine per indicated horse power per hour:

| Type of Engine | Gas | Coal |
|---|---|---|
| | Cubic Feet | Pounds |
| Large natural-gas engine, highest type | 9 | 0.9 |
| Ordinary natural-gas engine | 13 | 1.3 |
| Triple expansion condensing steam engine | 16 | 1.6 |
| Double expansion condensing steam engine | 20 | 2.0 |
| Single cylinder and cut-off steam engine | 40 | 4.0 |
| Ordinary high pressure, without cut-off, steam engine | 80 | 8.0 |
| Ordinary oil well pumping steam engine | 130 | 13.0 |

"*Uses.* Natural gas is used in domestic service principally as a source of heat and light. It is employed extensively in industrial establishments for many purposes, notably in the generation of steam; in the manufacture of glass, puddling of iron; in roasting ores; in heating furnaces, for lacquering and japanning, annealing and reheating, case hardening, tool tempering, preheating castings in oxy-acetylene welding; and for heating china kilns, water stills, fire expanders, etc.; and in the manufacture of steel and pottery; it is also utilized as a source of power in the gas engine in oil field work, and as a general source of power for all purposes. To conserve the supply, manufactured gas is mixed with it. The heat value stored in natural gas is greater than that caused

by any artificial combination of carbon and hydrogen, and it is a perfect fuel as it issues from its original rock-sealed reservoirs. No preparation is necessary for its combustion, and no residue is left. It is not affected by ordinary temperature and it is easily distributed by pipes to points of consumption. It is a most economical source of light and power, and an idea household fuel. Carbon black (q. v.) is the only commercial article that is made directly from natural gas.

"Since 1911 a considerable industry has been built up in the production of gasoline from casing-head gas—that is the gas which comes up between the casing and the tubing of an oil well, and collects in the casing head. This gas is known as 'wet' gas, carrying a proportion of the vapor of petroleum. The process is also applied to gas from gas wells if it carries as much as six pints of gasoline vapor to the 1,000 cubic feet. For the wetter gases the principle of compression is employed, with subsequent condensation. For the dryer gases the process is to pass the gas through a tank of heavy oil which absorbs the gasoline vapor, and the gasoline is afterward distilled out. In 1923 there were in the United States 1,067 plants devoted to the production of gasoline from natural gas. The total recovery was 816,226,000 gallons, nearly a third of which was gained in Oklahoma. A yield as high as eight gallons of gasoline per 1,000 cubic feet is obtainable. In addition to the oil absorption method absorption by charcoal has been developed."

DEPARTMENT OF COMMERCE
William F. Whiting, Secretary

BUREAU OF MINES
Scott Turner, Director

# NATURAL GAS

## IN 1927

By G. R. HOPKINS and H. BACKUS

Mineral Resources of the United States, 1927—Part II
(Pages 129–137)

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# NATURAL GAS

By G. R. Hopkins and H. Backus

The history of the natural-gas industry in 1927 was similar to that of the petroleum industry in that a record output was marketed at reduced prices. The total quantity of natural gas produced in the United States and delivered to consumers in 1927 amounted to the huge total of 1,445,428,000,000 cubic feet, an increase over 1926 of 132,409,000,000 cubic feet, or 10 per cent; this increase compares with increases of 10 and 4 per cent in 1926 and 1925, respectively, over the preceding year. During 1927, 184,000,000 cubic feet of gas produced in the United States was piped to Canada and Mexico, and 1,445,244,000,000 cubic feet was consumed within the United States. The value of the gas per thousand cubic feet at the wells decreased from 9.5 cents in 1926 to 8.8 cents in 1927 and at points of consumption from 22.9 cents in 1926 to 22.0 cents in 1927. In spite of the material increase in quantity of gas utilized in 1927, the total value at wells and at points of consumption showed but slight increases over 1926.

In 1927 domestic (household) consumers—3,984,000—of natural gas in the United States used a total of 296,036,000,000 cubic feet. These figures represent an increase of nearly 254,000, or 7 per cent, in the number of domestic consumers, but an increase of only 2 per cent in the total domestic consumption. The average consumption in 1927 per domestic consumer, 74,300 cubic feet, as compared with 77,500 cubic feet in 1926, was lower for the fourth consecutive year; this decrease in average consumption was probably the result of more efficient use. The average price paid for natural gas by domestic consumers in 1927 was 60.8 cents per thousand cubic feet, as compared with 58.4 cents in 1926. As an illustration of the steady increase in the price paid by domestic consumers for gas, it may be cited that the 1927 price was almost twice the 1917 price, and that the last annual decrease in average price was in 1908. On the basis of the consumption and price data given, the natural-gas bill of the average domestic consumer in 1927 was $3.76 per month, or $45.17 for the year. Ohio continued to lead the States in number of domestic consumers and was again followed by California and Pennsylvania. California recorded the largest increase in number of domestic consumers in 1927 as well as the largest increase in average value. This unusual relation would seem to indicate that the price of natural gas for household use is a minor factor from the point of view of the consumer. Only three States—Indiana, Missouri, and Tennessee—reported a decrease in 1927 in number of domestic consumers.

The relative rank of the large natural-gas producing States was materially changed in 1927. Oklahoma retained first place, Texas advanced from fourth to second place, and Louisiana from fifth to

fourth. California dropped from second to third place and displaced West Virginia which dropped to fifth place. The output in Oklahoma increased 14 per cent in 1927, chiefly as the result of production incidental to the intensive drilling for oil at Seminole. Texas showed the largest increase in output—45 per cent—of all the major gas-producing States; as in Oklahoma, this increase was due to oil development, particularly that in the Panhandle.

The total consumption of natural gas (including residue gas from natural gasoline plants) by industrial users in 1927 amounted to 1,149,208,000,000 cubic feet, an increase over 1926 of 12 per cent; this total was divided about equally between field use (that is, for drilling, pumping, and operating gasoline recovery plants) and other industrial uses (including gas burned in making carbon black and gas used by manufacturing establishments). Virtually all of the increase in consumption of gas for field purposes was in Oklahoma and Texas and was the result of an intensive drilling campaign in those States. The major part of the increase in consumption of gas for other industrial purposes was in Louisiana, where refiners were using it as fuel more extensively than in previous years, and in Texas where carbon black manufacturers in the Panhandle district and industrial plants in the Texas Gulf coast district were using it in increasing quantities. The total value of the gas consumed for field and other industrial purposes in 1927 amounted to $137,785,000, as compared with $131,185,000 in 1926. The average value per thousand cubic feet for industrial gas dropped from 12.8 cents in 1926 to 12 cents in 1927; this fact accounts for the small increase in total value in the face of a 12 per cent gain in consumption. In general, the price of gas for industrial purposes has shown little change in the past 10 years, whereas, as previously noted, the price of gas for domestic consumption has increased steadily. This condition is due mainly to the fact that the fields near the centers of population have declined in output and the only prolific gas fields found in the past several years are in comparatively isolated localities.

Despite the low prices that prevailed for natural gasoline in 1927, the tendency to extract the greatest possible amount from the gas was again marked. A total of 1,341,248,000,000 cubic feet of natural gas, or 93 per cent of the total production, was treated for the recovery of natural gasoline in 1927. In 1926 the proportion treated was 92 per cent.

The interstate movement of natural gas in 1927 amounted to 194,401,000,000 cubic feet, a decrease of 7 per cent from 1926. The movement of gas from West Virginia continued to be of first importance despite a decrease of 13 per cent from 1926; this decrease was probably due to both declining production in West Virginia and slow but steady increase in the output of Ohio.

*Summary of statistics for natural gas in the United States, 1923–1927*

| | 1923 | 1924 | 1925 | 1926 | 1927 |
|---|---|---|---|---|---|
| Natural gas consumed: | | | | | |
| Domestic.....millions of cubic feet.. | 277,050 | 285,152 | 272,146 | 289,175 | 296,036 |
| Industrial— | | | | | |
| Carbon black.....do.... | 109,096 | 156,514 | 140,366 | 130,321 | 144,087 |
| Field.....do.... | 343,076 | 393,437 | 423,524 | 478,188 | 549,455 |
| Other industrial.....do.... | 277,745 | 306,379 | 352,403 | 415,169 | 455,666 |
| | 1,006,967 | 1,141,482 | 1,188,439 | 1,312,853 | 1,445,244 |
| Domestic.....per cent.. | 27.5 | 25 | 23 | 22 | 20 |
| Industrial.....do.... | 72.5 | 75 | 77 | 78 | 80 |
| Used for natural gasoline: | | | | | |
| Millions of cubic feet..... | 875,711 | 1,016,276 | 1,040,390 | 1,206,300 | 1,341,248 |
| Per cent of total consumption..... | 87.0 | 89 | 88 | 92 | 93 |
| Domestic consumers.....thousands.. | 3,234 | 3,443 | 3,508 | 3,731 | 3,964 |
| Value of natural gas at wells: | | | | | |
| Total.....thousands of dollars.. | 100,849 | 105,779 | 112,047 | 124,693 | 127,468 |
| Average per M cubic feet.....cents.. | 10.0 | 9.3 | 9.4 | 9.5 | 8.8 |
| Value of natural gas at points of consumption: | | | | | |
| Total.....thousands of dollars.. | 239,993 | 253,830 | 265,184 | [1] 300,055 | 317,803 |
| Domestic.....do.... | 142,317 | 154,075 | 152,494 | [1] 168,870 | 180,018 |
| Industrial.....do.... | 97,678 | 99,755 | 112,690 | 131,185 | 137,785 |
| Average per M cubic feet— | | | | | |
| Domestic.....cents.. | 51.4 | 54.0 | 56.0 | 58.4 | 60.8 |
| Industrial.....do.... | 13.4 | 11.6 | 12.3 | 12.8 | 12.0 |
| Domestic and industrial.....do.... | 23.8 | 22.2 | 22.3 | 22.9 | 22.0 |
| Natural gasoline: | | | | | |
| Quantity.....thousands of gallons.. | 816,226 | 933,881 | 1,127,470 | 1,363,090 | 1,641,144 |
| Value at plants— | | | | | |
| Total.....thousands of dollars.. | 77,268 | 82,233 | 120,383 | 136,412 | 118,688 |
| Average per gallon.....cents.. | 9.5 | 8.8 | 10.7 | 10.0 | 7.2 |
| Carbon black: | | | | | |
| Quantity.....thousands of pounds.. | 138,263 | 186,872 | 177,417 | 180,576 | 198,429 |
| Value at plants— | | | | | |
| Total.....thousands of dollars.. | 11,692 | 11,565 | 9,640 | 9,939 | 10,965 |
| Average per pound.....cents.. | 8.5 | 6.2 | 5.4 | 5.5 | 5.5 |

[1] Revised figures.

*Natural gas produced and consumed in the United States, 1926–27.*

| State | Produced and delivered to consumers, including deliveries in other States | | | | | | Consumed, including receipts from other States | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Quantity | | Estimated value at the wells | | Value at points of consumption | | Quantity | | Value at points of consumption | |
| | M cubic feet | Per cent of total | Total | Average per M cubic feet (cents) | Total | Average per M cubic feet (cents) | M cubic feet | Per cent of total | Total | Average per M cubic feet (cents) |
| **1926** | | | | | | | | | | |
| Ark. | 43,566,000 | 3.3 | $2,000,000 | 4.6 | $5,817,000 | 13.4 | 52,630,000 | 4.0 | $7,027,000 | 13.4 |
| Calif. | 204,915,000 | 15.6 | 16,803,000 | 8.2 | [1] 36,425,000 | 17.8 | 204,915,000 | 15.6 | [1] 36,425,000 | 17.8 |
| Colo. | 553,800 | (2) | 50,000 | 9.0 | 130,000 | 23.5 | 503,800 | (2) | 125,000 | 24.8 |
| Ill. | 3,808,000 | .2 | 762,000 | 20.0 | 863,000 | 22.7 | 3,808,000 | .3 | 863,000 | 22.7 |
| Ind. | 901,000 | .1 | 377,000 | 41.8 | 379,000 | 42.1 | 1,854,000 | .1 | 906,000 | 48.9 |
| Kans. | 38,095,000 | 2.9 | 2,884,000 | 7.6 | 12,547,700 | 32.9 | 61,142,000 | 4.7 | 14,381,000 | 23.5 |
| Ky. | 10,410,000 | .8 | 961,000 | 9.2 | 3,378,000 | 32.4 | 18,126,000 | 1.4 | 6,119,000 | 33.8 |
| La. | 157,423,000 | 12.0 | 4,864,000 | 3.1 | 8,738,000 | 5.6 | 148,886,000 | 11.3 | 6,912,000 | 4.6 |
| Mich. | 400 | (2) | 40 | 10.0 | 200 | 50.0 | 400 | (2) | 200 | 50.0 |
| Mo. | 1,000 | (2) | 100 | 10.0 | 700 | 70.0 | 5,819,000 | .4 | 4,997,400 | 85.9 |
| Mont. | 2,283,000 | .2 | 86,000 | 3.8 | 450,000 | 19.7 | 3,295,000 | .2 | 650,000 | 19.7 |
| N. Mex. | 921,000 | .1 | 72,000 | 7.8 | 75,000 | 8.1 | 921,000 | .1 | 75,000 | 8.1 |
| N. Y. | [3] 7,027,000 | .5 | 2,237,000 | 31.8 | 4,499,000 | 64.0 | 17,864,000 | 1.4 | 11,443,000 | 64.1 |
| Ohio. | 47,363,000 | 3.6 | 8,781,000 | 18.5 | 25,403,000 | 53.6 | 115,719,000 | 8.8 | 65,982,000 | 57.0 |
| Okla. | 286,421,000 | 21.8 | 22,828,000 | 8.0 | 42,140,000 | 14.7 | 244,993,000 | 18.7 | 33,251,000 | 13.6 |
| Pa. | 107,089,000 | 8.2 | 25,112,000 | 23.4 | 50,040,000 | 46.7 | 125,836,000 | 9.6 | 56,724,000 | 45.1 |
| S. Dak. | 10,100 | (2) | 1,010 | 10.0 | 14,000 | 138.6 | 10,100 | (2) | 14,000 | 138.6 |
| Tenn. | 11,500 | (2) | 1,150 | 10.0 | 1,900 | 16.5 | 11,500 | (2) | 1,900 | 16.5 |
| Tex. | [4] 175,392,000 | 13.4 | 10,085,000 | 5.7 | 28,165,000 | 16.1 | 187,341,000 | 14.3 | 30,807,000 | 16.4 |
| W. Va. | 180,223,000 | 13.7 | 24,582,000 | 13.6 | 76,396,000 | 42.4 | 72,784,000 | 5.5 | 18,337,000 | 25.2 |
| Wyo. | 46,567,000 | 3.6 | 2,203,000 | 4.7 | 4,669,000 | 10.0 | 48,606,000 | 3.6 | 4,474,000 | 4.6 |
| Other [5] | 38,200 | (2) | 3,700 | 9.7 | 6,500 | 17.0 | 789,200 | .1 | 540,500 | 68.5 |
| | 1,313,019,000 | 100.0 | 124,693,000 | 9.5 | [1] 300,168,000 | 22.9 | 1,312,853,000 | 100.0 | [1] 300,055,000 | 22.9 |
| **1927** | | | | | | | | | | |
| Ark. | 30,450,000 | 2.1 | 1,486,000 | 4.9 | 4,281,000 | 14.1 | 40,916,000 | 2.8 | 5,751,000 | 14.1 |
| Calif. | 212,364,000 | 14.7 | 19,431,000 | 9.1 | 50,946,000 | 24.0 | 212,364,000 | 14.7 | 50,946,000 | 24.0 |
| Colo. | 1,725,400 | .1 | 173,000 | 10.0 | 290,000 | 16.8 | 1,544,000 | .1 | 277,000 | 17.9 |
| Ill. | 3,741,000 | .3 | 678,000 | 18.1 | 764,000 | 20.4 | 3,741,000 | .3 | 764,000 | 20.4 |
| Ind. | 1,124,000 | .1 | 406,000 | 36.1 | 509,000 | 45.3 | 2,166,000 | .1 | 1,076,000 | 49.7 |
| Kans. | 42,646,000 | 3.0 | 3,263,000 | 7.7 | 12,833,000 | 30.1 | 66,618,000 | 4.6 | 13,998,000 | 21.0 |
| Ky. | 10,206,000 | .7 | 946,000 | 9.3 | 3,277,000 | 32.1 | 16,694,000 | 1.2 | 5,608,000 | 33.6 |
| La. | 186,961,000 | 12.9 | 5,609,000 | 3.0 | 12,158,000 | 6.5 | 170,310,000 | 11.8 | 9,340,000 | 5.5 |
| Mich. | 600 | (2) | 50 | 8.3 | 300 | 50.0 | 600 | (2) | 300 | 50.0 |
| Mo. | 300 | (2) | 30 | 10.0 | 200 | 66.7 | 6,584,300 | .5 | 5,265,000 | 80.0 |
| Mont. | 4,253,100 | .3 | 131,800 | 3.1 | 716,400 | 16.8 | 5,455,000 | .4 | 918,000 | 16.8 |
| N. Mex. | 1,019,000 | .1 | 45,000 | 4.4 | 48,500 | 4.8 | 1,019,000 | .1 | 48,500 | 4.8 |
| N. Y. | [6] 5,908,000 | .4 | 1,731,000 | 29.3 | 3,841,000 | 65.0 | 16,174,500 | 1.1 | 10,514,000 | 65.0 |
| N. Dak. | 200 | (2) | 20 | 10.0 | 100 | 50.0 | 2,300 | (2) | 1,300 | 56.5 |
| Ohio. | 51,381,000 | 3.5 | 8,632,000 | 16.8 | 28,881,000 | 56.2 | 112,603,000 | 7.8 | 64,238,000 | 57.0 |
| Okla. | 326,864,000 | 22.6 | 21,508,000 | 6.6 | 41,391,000 | 12.7 | 286,485,000 | 19.8 | 33,503,000 | 11.7 |
| Pa. | 105,709,500 | 7.3 | 26,502,000 | 25.1 | 49,135,000 | 46.5 | 121,982,000 | 8.4 | 54,473,000 | 44.7 |
| S. Dak. | 92,000 | (2) | 8,130 | 8.8 | 136,500 | 148.4 | 92,000 | (2) | 136,500 | 148.4 |
| Tenn. | 9,000 | (2) | 800 | 8.9 | 2,200 | 24.4 | 9,000 | (2) | 2,200 | 24.4 |
| Tex. | [7] 254,063,000 | 17.6 | 11,204,000 | 4.4 | 37,424,800 | 14.7 | 269,944,000 | 18.7 | 40,141,000 | 14.9 |
| W. Va. | 162,375,000 | 11.2 | 23,918,000 | 14.7 | 67,994,000 | 41.9 | 66,200,000 | 4.6 | 17,062,000 | 25.8 |
| Wyo. | 43,581,600 | 3.0 | 1,765,000 | 4.0 | 3,269,800 | 7.5 | 42,559,000 | 2.9 | 3,080,000 | 7.2 |
| Other [5] | 954,300 | .1 | 30,170 | 3.2 | 31,200 | 3.3 | 1,781,300 | .1 | 632,200 | 35.5 |
| | 1,445,428,000 | 100.0 | 127,468,000 | 8.8 | 317,930,000 | 22.0 | 1,445,244,000 | 100.0 | 317,803,000 | 22.0 |

[1] Revised figures.
[2] Less than 0.1 per cent.
[3] Includes 79,000 M cubic feet consumed in Canada.
[4] Includes 87,000 M cubic feet consumed in Mexico.
[5] 1926: Alaska, Maryland (consumption only), and North Dakota; 1927: Alaska, Maryland (consumption only), Mississippi, and Utah.
[6] Includes 71,000 M cubic feet consumed in Canada.
[7] Includes 113,000 M cubic feet consumed in Mexico.

| State | Domestic | | | | Industrial | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Field (drilling, pumping, and operating gasoline recovery plants) | | Other industrial, including use in manufacture of carbon black | | | Total industrial | | |
| | Number of consumers | M cubic feet | Value at points of consumption | | M cubic feet (estimated) | Value at points of consumption (estimated) | M cubic feet | Value at points of consumption | | M cubic feet | Value at points of consumption | |
| | | | Total | Average (cents) | | | | Total | Average (cents) | | Total | Average (cents) |
| 1926 | | | | | | | | | | | | |
| Arkansas | 52,210 | 7,834,000 | $3,532,000 | 45.1 | 35,195,000 | $1,615,000 | 9,611,000 | $1,880,000 | 19.6 | 44,806,000 | $3,495,000 | 7.8 |
| California | 632,600 | 20,960,000 | [1] 15,731,000 | 75.1 | 123,953,000 | 10,177,000 | 60,002,000 | 10,517,000 | 17.5 | 183,955,000 | 20,694,000 | 11.2 |
| Colorado | 1,974 | 78,800 | 68,000 | 86.3 | 378,000 | 34,000 | 47,000 | 23,000 | 48.9 | 425,000 | 57,000 | 13.4 |
| Illinois | 11,910 | 203,000 | 142,000 | 70.0 | 3,605,000 | 721,000 | | | | 3,605,000 | 721,000 | 20.0 |
| Indiana | 13,860 | 722,000 | 386,000 | 53.5 | 72,000 | 30,000 | 1,060,000 | 490,000 | 46.2 | 1,132,000 | 520,000 | 45.9 |
| Kansas | 142,730 | 10,133,000 | 6,905,000 | 68.1 | 11,536,000 | 873,000 | 39,473,000 | 6,603,000 | 16.7 | 51,009,000 | 7,476,000 | 14.7 |
| Kentucky | 137,500 | 12,404,000 | 5,258,000 | 42.4 | 874,000 | 81,000 | 4,848,000 | 780,000 | 16.1 | 5,722,000 | 861,000 | 15.0 |
| Louisiana | 35,710 | 4,413,000 | 1,669,000 | 37.8 | 25,763,000 | 796,000 | 118,710,000 | 4,447,000 | 3.7 | 144,473,000 | 5,243,000 | 3.6 |
| Michigan | 6 | 400 | 200 | 50.0 | | | | | | | | |
| Missouri | 100,300 | 5,288,000 | 4,843,400 | 91.6 | | | 531,000 | 154,000 | 29.0 | 531,000 | 154,000 | 29.0 |
| Montana | 6,345 | 1,383,000 | 589,000 | 42.6 | 290,000 | 11,000 | 1,622,000 | 50,000 | 3.1 | 1,912,000 | 61,000 | 3.2 |
| New Mexico | 140 | 28,000 | 5,000 | 17.9 | 893,000 | 70,000 | | | | 893,000 | 70,000 | 7.8 |
| New York | 235,290 | 16,909,000 | 11,004,000 | 65.1 | 491,000 | 157,000 | 464,000 | 282,000 | 60.8 | 955,000 | 439,000 | 46.0 |
| Ohio | 1,124,080 | 87,672,000 | 53,970,000 | 61.6 | 3,130,000 | 580,000 | 24,917,000 | 11,432,000 | 45.9 | 28,047,000 | 12,012,000 | 42.8 |
| Oklahoma | 166,660 | 17,617,000 | 8,840,000 | 50.2 | 159,269,000 | 12,694,000 | 68,107,000 | 11,717,000 | 17.2 | 227,376,000 | 24,411,000 | 10.7 |
| Pennsylvania | 509,900 | 56,148,000 | 33,912,000 | 60.4 | 7,988,000 | 1,873,000 | 61,700,000 | 20,939,000 | 33.9 | 69,688,000 | 22,812,000 | 32.7 |
| South Dakota | 375 | 10,100 | 14,000 | 138.6 | | | | | | | | |
| Tennessee | 80 | 5,500 | 1,300 | 23.6 | 6,000 | 600 | | | | 6,000 | 600 | 10.0 |
| Texas | 279,380 | 18,045,000 | 11,986,000 | 66.4 | 69,369,000 | 3,996,000 | 99,927,000 | 14,825,000 | 14.8 | 169,296,000 | 18,821,000 | 11.1 |
| West Virginia | 165,800 | 25,700,000 | 8,166,000 | 31.8 | 14,225,000 | 1,940,000 | 32,859,000 | 8,231,000 | 25.0 | 47,084,000 | 10,171,000 | 21.6 |
| Wyoming | 11,280 | 2,880,000 | 1,314,000 | 45.6 | 21,136,000 | 1,000,000 | 21,589,000 | 2,160,000 | 10.0 | 42,725,000 | 3,160,000 | 7.4 |
| Other [2] | 12,670 | 751,200 | 534,100 | 71.1 | 15,000 | 1,400 | 23,000 | 5,000 | 21.7 | 38,000 | 6,400 | 16.8 |
| | 3,730,800 | 289,175,000 | [1] 168,870,000 | 58.4 | 478,188,000 | 36,650,000 | 545,490,000 | 94,535,000 | 17.3 | 1,023,678,000 | 131,185,000 | 12.8 |

[1] Revised figures.

[2] Alaska, Maryland, and North Dakota.

*Natural gas consumed in the United States, 1926–27*—Continued

| State | Domestic | | | | Industrial | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Field (drilling, pumping, and operating gasoline recovery plants) | | Other industrial, including use in manufacture of carbon black | | | Total industrial | | |
| | Number of consumers | M cubic feet | Value at points of consumption | | M cubic feet (estimated) | Value at points of consumption (estimated) | M cubic feet | Value at points of consumption | | M cubic feet | Value at points of consumption | |
| | | | Total | Average (cents) | | | | Total | Average (cents) | | Total | Average (cents) |
| 1927 | | | | | | | | | | | | |
| Arkansas | 57,190 | 6,419,000 | $2,900,000 | 45.2 | 20,576,000 | $1,019,000 | 13,621,000 | $1,382,000 | 13.4 | 34,497,000 | $2,851,000 | 8.3 |
| California | 745,440 | 34,309,000 | 30,125,000 | 88.3 | 121,393,000 | 11,107,000 | 55,362,000 | 9,714,000 | 17.6 | 177,055,000 | 20,821,000 | 11.8 |
| Colorado | 2,000 | 179,000 | 105,000 | 58.7 | 1,333,000 | 130,000 | 163,000 | 32,000 | 32.1 | 1,365,000 | 172,000 | 12.6 |
| Illinois | 12,150 | 164,000 | 116,000 | 70.7 | 3,577,000 | 648,000 | | | | 3,577,000 | 648,000 | 18.1 |
| Indiana | 13,530 | 738,000 | 415,000 | 53.1 | 97,000 | 35,000 | 1,288,000 | 626,000 | 48.6 | 1,385,000 | 661,000 | 47.7 |
| Kansas | 145,990 | 10,435,000 | 6,868,000 | 66.1 | 15,811,000 | 1,210,000 | 40,372,000 | 5,895,000 | 14.6 | 56,183,000 | 7,105,000 | 12.6 |
| Kentucky | 141,880 | 11,445,000 | 4,917,000 | 43.0 | 861,000 | 80,000 | 4,383,000 | 611,000 | 13.9 | 5,244,000 | 691,000 | 13.2 |
| Louisiana | 40,490 | 4,071,000 | 1,482,000 | 36.4 | 27,672,000 | 830,000 | 138,567,000 | 7,028,000 | 5.1 | 166,239,000 | 7,858,000 | 4.7 |
| Michigan | 10 | 600 | 300 | 50.0 | | | | | | | | |
| Missouri | 99,870 | 5,389,300 | 4,841,000 | 90.3 | | | 1,225,000 | 424,000 | 34.6 | 1,225,000 | 424,000 | 34.6 |
| Montana | 7,760 | 1,775,000 | 762,000 | 43.0 | 1,203,000 | 37,000 | 2,477,000 | 118,000 | 4.8 | 3,680,000 | 155,000 | 4.2 |
| New Mexico | 140 | 21,000 | 4,500 | 21.4 | 998,000 | 44,000 | | | | 998,000 | 44,000 | 4.4 |
| New York | 236,890 | 15,068,000 | 10,087,000 | 67.1 | 464,500 | 14,000 | 674,000 | 413,000 | 61.3 | 1,138,500 | 427,000 | 37.5 |
| North Dakota | 30 | 2,300 | 1,300 | 56.5 | | | | | | | | |
| Ohio | 1,149,760 | 83,686,000 | 52,055,000 | 62.2 | 3,679,000 | 618,000 | 25,270,000 | 11,602,000 | 45.9 | 28,949,000 | 12,220,000 | 42.2 |
| Oklahoma | 193,680 | 22,288,000 | 10,532,000 | 47.2 | 204,006,000 | 13,434,000 | 66,181,000 | 9,547,000 | 15.9 | 264,187,000 | 22,971,000 | 8.7 |
| Pennsylvania | 610,720 | 51,784,000 | 31,389,000 | 60.6 | 7,990,000 | 2,008,000 | 62,198,000 | 21,681,000 | 33.9 | 70,188,000 | 23,684,000 | 32.9 |
| South Dakota | 400 | 92,000 | 136,500 | 148.4 | | | | | | | | |
| Tennessee | 70 | 9,000 | 2,200 | 24.4 | | | | | | | | |
| Texas | 228,510 | 20,817,000 | 14,019,000 | 68.3 | 103,498,000 | 4,504,000 | 145,929,000 | 21,558,000 | 14.8 | 249,427,000 | 26,122,000 | 10.5 |
| West Virginia | 171,370 | 23,409,000 | 7,673,000 | 32.8 | 15,864,000 | 2,337,000 | 26,930,000 | 7,072,000 | 26.3 | 42,794,000 | 9,409,000 | 22.0 |
| Wyoming | 12,780 | 2,638,000 | 1,070,000 | 40.6 | 20,234,000 | 819,000 | 19,687,000 | 1,191,000 | 6.0 | 39,921,000 | 2,010,000 | 5.0 |
| Other [1] | 14,290 | 627,800 | 508,200 | 80.9 | 38,500 | 3,000 | 1,115,000 | 109,000 | 9.8 | 1,153,500 | 112,000 | 9.7 |
| | 3,964,400 | 296,036,000 | 180,018,000 | 60.8 | 549,455,000 | 38,912,000 | 599,753,000 | 98,873,000 | 16.5 | 1,149,208,000 | 137,785,000 | 12.0 |

[1] Alaska, Maryland, Mississippi, and Utah.

*Interstate transportation of natural gas, in thousands of cubic feet, 1926–27*

| State in which gas was produced | State to which gas was transported | 1926 | 1927 |
|---|---|---|---|
| Colorado | Wyoming | 50,000 | 181,400 |
| Indiana | Kentucky | 408,000 | 306,000 |
| Kansas | Missouri | 5,815,000 | 6,584,000 |
| | Oklahoma | 414,000 | 104,000 |
| | | 6,232,000 | 6,688,000 |
| Kentucky | West Virginia | 1,595,000 | 1,955,000 |
| Louisiana | Arkansas | 8,053,000 | 10,215,000 |
| | Mississippi | | 14,000 |
| | Texas | 6,419,000 | 10,884,000 |
| | | 14,482,000 | 21,113,000 |
| Montana | North Dakota | | 2,100 |
| New York | Canada | 79,000 | 71,000 |
| | Pennsylvania | 17,000 | 500 |
| | | 96,000 | 71,500 |
| Ohio | Indiana | 1,361,000 | 1,348,000 |
| | West Virginia | 4,709,000 | 1,102,000 |
| | | 6,070,000 | 2,450,000 |
| Oklahoma | Arkansas | 236,000 | 251,000 |
| | Kansas | 29,279,000 | 30,660,000 |
| | Texas | 12,327,000 | 9,572,000 |
| | | 41,842,000 | 40,483,000 |
| Pennsylvania | New York | 10,933,000 | 10,236,000 |
| | Ohio | 1,429,000 | 1,698,000 |
| | West Virginia | 2,419,000 | 2,052,000 |
| | | 14,781,000 | 14,088,000 |
| Texas | Arkansas | 765,000 | |
| | Louisiana | 5,945,000 | 4,462,000 |
| | Mexico | 87,000 | 113,000 |
| | | 6,797,000 | 4,575,000 |
| West Virginia | Kentucky | 8,903,000 | 8,137,000 |
| | Maryland | 751,000 | 812,000 |
| | Ohio | 72,997,000 | 61,974,000 |
| | Pennsylvania | 33,511,000 | 30,360,000 |
| | | 116,162,000 | 101,284,000 |
| Wyoming | Montana | 1,012,000 | 1,204,000 |
| | | 209,527,000 | 194,401,000 |

*Natural gas produced in the United States and delivered to consumers, 1918–1927, by States, in millions of cubic feet*

| Year | Arkansas | California | Illinois | Indiana | Kansas | Kentucky | Louisiana | Montana | New York | Ohio | Oklahoma | Pennsylvania | Texas | West Virginia | Wyoming | Others | Total | Value at points of consumption | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | Total (thousands of dollars) | Average per M cubic feet (cents) |
| 1918 | 5,295 | 39,719 | 4,473 | 1,667 | 27,825 | 3,022 | 36,094 | 177 | 8,461 | 61,261 | 124,317 | 123,813 | 13,440 | 265,161 | 4,339 | 1,937 | 721,001 | 153,554 | 21.3 |
| 1919 | 5,587 | 55,607 | 3,825 | 1,407 | 16,150 | 2,057 | 47,062 | 858 | 8,124 | 63,153 | 163,649 | 113,489 | 24,710 | 234,095 | 6,014 | 129 | 745,916 | 160,883 | 21.6 |
| 1920 | 9,027 | 66,041 | 3,013 | 1,779 | 21,158 | 3,345 | 58,274 | 818 | 8,419 | 58,938 | 154,467 | 125,787 | 37,063 | 239,719 | 10,312 | 50 | 798,210 | 196,194 | 24.6 |
| 1921 | 4,260 | 75,942 | 2,646 | 1,066 | 15,717 | 4,820 | 58,004 | 336 | 6,583 | 47,472 | 124,058 | 86,144 | 44,504 | 174,921 | 15,608 | 31 | 662,052 | 174,617 | 26.4 |
| 1922 | 9,700 | 84,580 | 3,383 | 947 | 20,289 | 5,872 | 70,267 | 486 | 6,947 | 51,481 | 140,631 | 101,276 | 47,945 | 195,288 | 23,427 | 27 | 762,546 | 221,535 | 29.1 |
| 1923 | 24,215 | 131,434 | 4,049 | 880 | 30,913 | 11,953 | 112,031 | 1,470 | 6,497 | 53,812 | 203,082 | 112,562 | 74,535 | 203,867 | 35,523 | 153 | 1,006,976 | 240,001 | 23.8 |
| 1924 | 36,616 | 189,692 | 4,072 | 998 | 25,580 | 12,875 | 160,945 | 1,071 | 6,196 | 47,396 | 214,452 | 105,863 | 107,247 | 182,285 | 46,036 | 197 | 1,141,521 | 253,856 | 22.2 |
| 1925 | 41,878 | 187,789 | 4,165 | 1,168 | 26,917 | 10,770 | 152,620 | 1,496 | 6,210 | 43,235 | 249,285 | 101,632 | 134,872 | 180,345 | 45,530 | 650 | 1,188,571 | 265,271 | 22.3 |
| 1926 | 43,566 | 204,915 | 3,808 | 901 | 38,095 | 10,410 | 157,423 | 2,283 | 7,027 | 47,363 | 286,421 | 107,089 | 175,392 | 180,223 | 46,567 | 1,536 | 1,313,019 | [1]300,168 | 22.9 |
| 1927 | 30,450 | 212,364 | 3,741 | 1,124 | 42,646 | 10,206 | 186,961 | 4,253 | 5,908 | 51,381 | 326,864 | 105,709 | 254,063 | 162,375 | 43,582 | 3,801 | 1,445,428 | 317,930 | 22.0 |

[1] Revised figures.

*Statistics of natural gas in the United States, 1918–1927*

| Year | Produced and delivered to consumers (billions of cubic feet) | Treated for recovery of natural gasoline | | Domestic consumption | | | | | Industrial consumption | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Billions of cubic feet | Per cent of total consumption | Number of consumers (thousands) | Billions of cubic feet | Average number of M cubic feet used per consumer | Per cent of total consumption | Average value at points of consumption per M cubic feet (cents) | Field (billions of cubic feet) | Carbon black (billions of cubic feet) | Other industrial (billions of cubic feet) | Total industrial (billions of cubic feet) | Per cent of total consumption | Average value at points of consumption per M cubic feet (cents) |
| 1918 | 721 | 449 | 62 | 2,509 | 271 | 108.1 | 38 | 31.4 | [1] | [1] | [1] | 450 | 62 | 15.2 |
| 1919 | 746 | 480 | 64 | 2,501 | 256 | 102.2 | 34 | 34.6 | 170 | 50 | 270 | 490 | 66 | 14.8 |
| 1920 | 798 | 496 | 62 | 2,615 | 286 | 109.4 | 36 | 38.2 | 202 | 41 | 269 | 512 | 64 | 17.0 |
| 1921 | 662 | 465 | 70 | 2,631 | 248 | 94.4 | 38 | 44.4 | 182 | 51 | 181 | 414 | 62 | 15.5 |
| 1922 | 763 | 545 | 71 | 3,015 | 255 | 84.4 | 33 | 49.9 | 198 | 54 | 256 | 508 | 67 | 18.6 |
| 1923 | 1,007 | 876 | 87 | 3,234 | 277 | 85.7 | 28 | 51.4 | 343 | 109 | 278 | 730 | 72 | 13.4 |
| 1924 | [2] 1,142 | 1,016 | 89 | 3,443 | 285 | 82.8 | 25 | 54.9 | 393 | 157 | 306 | 856 | 75 | 11.6 |
| 1925 | [2] 1,189 | 1,040 | 88 | 3,508 | 272 | 77.6 | 23 | 56.0 | 424 | 140 | 352 | 916 | 77 | 12.3 |
| 1926 | [2] 1,313 | 1,206 | 92 | 3,731 | 289 | 77.5 | 22 | [3] 58.4 | 478 | 131 | 415 | 1,024 | 78 | 12.8 |
| 1927 | [2] 1,445 | 1,341 | 93 | 3,984 | 296 | 74.3 | 20 | 60.8 | 549 | 144 | 456 | 1,149 | 80 | 12.0 |

[1] Figures not available.

[2] Includes gas piped to Canada and Mexico.

[3] Revised figures.

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